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THE

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JANUARY, 1881.

I. LIFE AND ITS BASIS.

By J. H. Barker, M.A.

Part I.—*Vegetable Life.*

AMONG the many new "ologies" to which the rapid progress of Science in the present age has given birth, none perhaps are at once so interesting and so encompassed with difficulties as Biology and Psychology; and for this obvious reason, that these subjects lie upon the very boundary of the "vast unknown," and trench to no small extent upon the domain of Philosophy, secular or sacred,—indeed upon that of both,—demanding a reverent caution, and entire freedom from dogmatism in the handling of them.

While offering a few suggestions upon the former of these two subjects, I shall make no attempt to criticise the views of others,—a task wholly impossible within the limits of a short article like the present,—but content myself with stating the conclusions at which I have myself arrived.

The problem of Life may well be termed, *par excellence*, the "Crux" of Science. As the Duke of Argyll observes, in a recent article on 'The Unity of Nature,'—in the "Contemporary,"—"Science has cast no light on the ultimate nature of life." Familiar as we are with the fact and the phenomena of life, its actual nature seems for ever to elude our grasp. Science can experiment *ad libitum* upon non-living matter, and to a certain limited extent upon the *living*, and is compelled to confess that a vast difference exists between them. It can apply its microscope, and discern the wonderful and minute motions peculiar to life, at least in its active state, and can estimate the effects which chemical

and physical stimuli produce on it; but the question, What *is* life? remains without any satisfactory answer.

Few, if any, of the definitions of *life* are more than an enunciation of some of the principal phenomena presented by living beings. They may be very true as accounts of the *actings* of life, but they tell us nothing as to its nature. These phenomena are *effects*, but what is their *cause?* The conviction is irresistible that there is *something*—a *quicquid ignotum*—behind them, which is beyond our ken. And so, no doubt, there is.

But, after all, is Life a *thing* at all? Is it a distinct *entity*, which can be properly said to be attached or added to, or taken from, matter? In conventional language, life may be said to *dwell* in an organism, or to *depart* or be *taken* from it. But it does not follow that this is philosophically correct in respect of either of the great provinces of life. And the main object of the present article will be to show that there is good ground for thinking that the vital principle, in our own world at least, is *not* a separate entity, such as Mind and Matter are; nor yet molecular motion in matter, as some will have it to be, but a temporary state of certain kinds of matter, which is produced and regulated in them by "mind."

In an enquiry of this nature precision in the use of terms is of essential importance. When this is neglected the reader is often left in a mental fog, the word "life" being sometimes used for its "principle," sometimes for its attributes or phenomena; and again, for its duration, or still more frequently, for the whole series of living things around us. I shall endeavour to avoid this confusion of thought, and to restrict the word to the first of these meanings, viz., the principle which distinguishes (to use Prof. Haeckel's phraseology) the *organa* from the *anorgana*.

I may further observe, *in limine*, that many physiologists speak of this principle as a force or power controlling, to a certain extent, the physical forces of Nature. This, which is quite true phenomenally, seems necessarily to imply that they regard it as a being possessing power and intelligence, and exerting volition. Another school of physicists, taking note of the perpetual motion manifested in the minutest molecules which can be discerned in animal and vegetable* cells, are disposed to identify the causes of these living motions with those of the motions exhibited in inorganic

* I should prefer myself to adopt Henslow's terminology, "vegetal," when used as an adjective, on etymological grounds, but conform here to the common usage.

matter, such as heat, electricity, or magnetism.* To this view I may have to revert in a subsequent part of this paper.

It is now generally agreed that life (on our earth at least) is never found except as associated with a certain chemical compound to which the name of "protoplasm" has been assigned, consisting of the elements carbon, hydrogen, oxygen, and nitrogen, technically represented as CHON—animal forms comprising all four, while vegetables, with a few exceptions, contain only the first three. In the living organisms the proportions of these elements vary indefinitely, and also include some other elements, as phosphorus, &c. It is, however, by no means certain that protoplasm is chemically identical in the two kingdoms of Nature, or even that it is precisely the same in every species.

But let us assume that Prof. Huxley was justified in considering this albuminous compound to be "the physical basis of life,"—indeed "the *matter* of life,"—and that, in reality, all living structures are built upon this foundation. No one will contend, however, that this arrangement was a *necessary* one. It is quite as conceivable that life might have been conferred on portions of elementary matter, as metals or gases. If any reason can be assigned for the actual basis being an unstable compound, it is that it was *intended* that this *basis* should be liable to change and dissolution,—*i.e.*, that it was designed to be only a temporary provision.

There is, however, another general consideration, the importance of which is often underrated. It has been assumed, with respect both to protoplasm and to the organised tissues produced from it, that the static condition of the component elementary substances in them is the same in the living and the dead state. Now chemical analysis can only deal with matter in its non-living state; and however exact this analysis may be, it is really begging the question to assume that the component elements are in the same state in living and in non-living organisms. Sulphur, phosphorus, carbon, and oxygen itself, are known to be susceptible of different forms or states: and of these differences chemistry can give no account, in the present state at least of our knowledge. Living protoplasm, therefore, may be something more than a mere chemical compound. The chemist may unite the elements CO and produce carbonic acid, or HN and form ammonia, or HO and exhibit water. He may further imitate the operations of organic chemistry, and form some of the

* *See* Huxley's Lay Sermon on Protoplasm.

simpler products (*e.g.*, urea); but he has never yet succeeded in forming albumen, much less living protoplasm, without the aid of matter which is already in a living state. But this power does appear to be possessed by living matter, both vegetable and animal. The former acts upon the binary compounds above mentioned when in immediate contact, under certain conditions of temperature, and appropriates some of their elements, which it seems to imbue with its own life and special character; it *assimilates* them. But, let it be observed, this action is confined to *some* of the elements, to the exclusion of others. It is a case of what may most properly be called "Natural Selection." The living substance may be said to *choose* its food, for it is thus that it *grows*.

Deeply interesting and instructive are the revelations of microscopic physiology, as exhibited, for example, in Dr. L. Beale's well-known work on "Protoplasm and Life." But I can only here allude to a *dictum* which he was fully competent to pronounce, that "the progression from the inorganic to the living is not to be traced step by step. The change is instantaneous. The life *flashes*, as it were, into the inanimate particles, and they *live*." *

Perhaps the best path to take, in order to reach a definite conclusion in regard to the subject before us, will be to trace the history of an individual organism during its term of life. Let us begin with the vegetable. We must start, of course, with the seed, or rather with the germinal cell, which is the origin of the future plant. But a difficulty meets us at once; for the earliest form to which this germ can be traced is nothing but an atom of simple undifferentiated jelly, largely composed of water, without any apparent structure. But have we gone back far enough even now? This atom of protoplasm is *already alive*. It is, however, composed of elements which at one time were non-living, viz., carbon, hydrogen, and oxygen. These elements are now chemically united in the proportions which form albumen. But what force united them thus? Prof. Haeckel† and other writers of the same school start from the formed chemical substance; but they should begin at least one step farther back in their analysis before it can be called exhaustive. For what are these same chemical affinities to which they ascribe the origination of vitality? Are the elementary substances—carbon, &c.—*living beings*, who can

* Beale's Protoplasm and Life, p. 278.
† *See* History of Creation, vol. i., chap. xiii..

choose to combine in definite atomic ratios? They may indeed *seem* to be alive, if motion is to be taken as an adequate proof of life. Indeed, upon this ground, Haeckel consistently enough argues (vol. i., p. 23) that "all material bodies which are known are equally animated." This may indeed be a real and a grand truth, though in a sense perhaps not intended by its author.

But if this were granted, it does not prove that there is no *difference* between the forces which produce living and non-living things; for the same principle or power may surely act in widely diverse manners, in order to produce certain results. Physico-material motions and physico-vital movements, as they alike require and imply power for their cause, so do they alike demand intelligence to direct and apply them.

To proceed with our history. We have now got a non-living compound called protoplasm, as the result of the action of some power upon inert manner. But how does it become *living*? All investigation seems to show that, while the contact of living protoplasm is indispensable to this process, nothing tangible is added to the non-living matter. Dr. Huxley compares it to the change of oxygen and hydrogen into water, under the term "aquosity," but confesses that the influence of living upon dead matter is "unintelligible" ("Lay Serm.," p. 150). It is so except upon one hypothesis, that a power is here acting which proceeds upon the rule or method (as far as we can scrutinise it) to commence from living matter, and to vivify particles in immediate contact with it,—not to communicate life to unattached inorganic matter. To infer from this, however, that such an action *never* takes place, is illogical and unphilosophical; and still more so, that it cannot and never has taken place. Even Haeckel admits that in certain primeval conditions of the earth's surface "spontaneous generation," or, as it should more accurately be expressed, the vivification of inorganic elements, may have occurred (*see* "Hist. of Creation," vol. i., p. 341). The term "spontaneous" was intended to refer to the "will" of the living being, who was supposed capable of calling itself into existence—a palpable absurdity. But if it is called into being by the *will* of another, the hypothesis becomes a reasonable one—indeed the equivalent of "creation." And what essential difference, it may be asked, is there between the two cases? In the one there is contact with living matter, and in the other not; and that is all. Nor can we be sure that any contact, however close, would make the transfer of life a necessary consequence. The

contact of the "bioplast" (to use Dr. Beale's apt phrase) with "formed" or dead matter is as close as can be imagined; but the transfer of "life" has ceased. The initiation, therefore, of the living state in the lifeless, *whether it has formerly been alive or not*, must be due to the action of an unseen higher power.

This remark applies to all vegetative growth in earth and air and sea, and must have been equally so at every instant during countless past ages, since vegetation first appeared upon our planet. And the first giving of "life" to the lifeless, to form it into the simplest vegetable cell, must (I conceive) have been the very same in whatever part of the terraqueous globe it appeared. It may be, as Darwin and others suppose, that a few primordial speciea of plants were originally formed, from which all other forms have sprung by ordinary propagation. But it is this "ordinary propagation" itself that involves, at every step, an action which exact thought cannot distinguish from the first impartation of life to inert matter. The fact that the same process is for ever going on under our eyes must not be allowed to blind us to the rational inference, that the action and the power are virtually the same in both cases; although the original act is called "creation," and the perpetual act "a natural process": both alike imply the exertion of power and will.

I may be allowed to fortify my argument on this point by the remarkable admissions of two eminent scientists of the present day. In his famous "Belfast Address" (p. 54) Prof. Tyndall, referring to Darwin's idea above alluded to, says that "the anthropomorphism which it seemed his object to set aside is as firmly associated with the creation of a few forms as of a multitude. We need clearness and thoroughness here. Two courses, and two only, are possible. Either let us open our doors freely to the conception of creative acts, or, abandoning them, let us radically change our notions of matter." This means that the belief that matter is, *per se*, *passive*, carries with it the belief in creative acts. In this I fully concur, for the contrary view virtually turns *Matter* into *Mind*.

In discussing the possibility of Spontaneous Generation, Prof. Haeckel ("Hist. of Creation," vol. i., p. 348) adduces the case of the Monera. In his classification of living things he makes a *third* kingdom of the lowest organisms in both the ordinary departments of life, and terms them "Protista," of which the Monera are the simplest and perhaps lowest forms. The following remarks will therefore

hold good either for animals or vegetables. And he finds himself in this dilemma: *either* these organisms must have been created millions of years ago, and propagated themselves unchanged until now,—a conclusion directly subversive of Darwin's views and his own,—*or* they must have been, and may even now be, produced by spontaneous generation. To escape from the former alternative he throws himself upon the latter, which, by his own showing, means that dead or inert matter can *give itself life!*—a manifest absurdity. But it is no absurdity to suppose that a Supreme Mind may, at any time, confer life upon non-living matter, seeing that this process is constantly going on both in the animal and vegetable worlds.

I have dwelt at some length upon this part of my subject, because it is the crucial point of the controversy respecting life. It is perfectly true, as Dr. Beale maintains, that there is the greatest conceivable difference between living and non-living things. But the real efficient cause of these different conditions of matter must be one co-extensive with the living world around us,—indeed, as we have already seen, with the whole inorganic world and the activities manifested in it.

To return now to our living protoplasm, or *bioplasm* as Dr. Beale calls it. If it is to grow into a *plant* the three elements C, O, and H will suffice as components. We have supposed it to be the inceptive particle of the nascent germ. To this basis are attached from the substance of the seed, which is yet soft protoplasm, cells and groups of cells,—and the germ *grows*. But it grows not at random, but in a different and yet definite manner for each particular kind of plant. What power, then, guides and adjusts these cells that they produce specific forms? But now the seed with its enclosed germ is completed; it is ripe; *i.e.*, the water it contained is either evaporated or decomposed, and the seed (let it be a grain of corn) may now remain in what seems a lifeless state for years, and even for ages, and may yet at last *spring* into life. Now this involves some theory of *dormant* life; but how can such dormancy, or the continued existence of life, be anything more than an assumption, when it is only by *active* motions that the presence of life is proved? The fact that the combined action of light and heat, of air and water, revives the dry germ and restores it to life, only proves that the germ has not been disintegrated, and that the activity of those elements is the *means* of restoring the vital condition to it; in short, that this dormancy is the temporary cessation of the action which we recognise as *life*.

But I wish to observe here that *conditions* necessary to life are not the *causes* of it. The human mind has the power of constructing and putting together the various parts of a machine, and of imposing the *conditions* of its action, and it is that *mind* that is the *cause* of its acting in any particular way. Just so are the " presence " and agency of *mind* absolutely requisite to initiate and continue the motions which, as far as physical evidence goes, constitute vegetable life.*

It is not necessary for my present purpose to enter further into the mysterious arcuna of vegetable embryology. The same principle of life, whatever it be, undoubtedly presides over all the multifarious functions and processes of vegetable organisation. Its progress is a succession of alternations of life and death ; first of the material particles which compose the organism, and then the death of the whole organism. It is a perpetual entry and departure of the atoms of the " anorgana " into the substance of the organism ; and, as *life* is the continuance of this action, so death is its cessation, in any molecule, or organ, or individual plant. With regard to one of the main conditions of vitality, viz., certain degrees of temperature, it is only by observation and experiment that we can know the range of heat which is compatible with the continuance of life in any particular case. In a large majority of instances it appears to be very limited ; but it is difficult to imagine any physical necessity for the appointment. All we can say is, that *so it is*. It has been particularly observed *àpropos* of the experiments made by the late Mr. Crosse, which were at the time thought by many physicists to prove the theory of spontaneous generation, that though it was assumed that the heat of boiling water had which his infusions were subjected *must necessarily* have destroyed every living germ, yet the fact of the reappearance even when air was excluded, of amœboid forms of life, rather went to prove that their germs were capable of passing through such a temperature *without* losing their vitality. On the other hand, we do not know *what* degree of *cold* a seed when quite dry will bear without its germinating power being destroyed ; or, more correctly, what limits are actually set to their restoration to the vital state in regard to the temperature to which they may be exposed.

But a question here suggests itself, which I have no reason to blink, viz., whether some of the vital phenomena of plants do not indicate the presence of a power of choice and selection in the individual organism itself exerted for its own

* See Sir J. HERSCHEL'S Popular Lectures, p. 458.

purpose. If such individual choice could be clearly proved, it would seem to carry with it the admission of the existence of a physical entity in each separate plant, and indeed in every separate cell, which would be equivalent to regarding vegetable life as an assemblage of such entities, undistinguishable from those of animals. On this subject, however, we cannot do better than accept the opinion expressed by Mr. Darwin in his new work on "The Power of Movement in Plants." He traces the remarkable actions of many plants, which he describes under the name of *circumnutation*, to the influence of external conditions, as light, heat, electricity, &c., causing various contractions and expansions of their cellular tissues, rather than to the existence of any internal cause. But this interesting though admittedly obscure branch of vegetable physiology abounds with instances of contrivance, which clearly prove *design*, and indicate the presence of will and purpose in an unmistakable manner, somewhere.

It has become an axiom in physiology that chemistry is controlled and often suspended by life. The explanation of this phenomenon by our present theory is easy and direct. Both activities are in reality manifestations of the same power working in different ways, and the last dominates the other, when the purposes of the living organism are to be answered by it. When these purposes have been fulfilled, and the living state has ceased to exist, the ordinary chemical forces predominate, and dissolve the organism into its former elements.

I have more than once had occasion to advert to the conditions in which living vegetation exists, such as air, water, light, heat, &c. And there is no question as to the large part these conditions play in the ever-shifting scenery of this most beatiful department of Nature. But with regard to the last-mentioned influences, something more remains to be said. Believing, as I do, in the highly probable doctrine that the three constituents of the solar ray, heat, light, and actinism, are only different rates of vibration in the same medium, viz., the æther, and that, moreover, this medium is suffused through all other material bodies, and, in fact, forms a constituent part of them,—and especially so in the case of air and water,—I am fully prepared to recognise the æther combined with protoplasm and its resultants in vegetable organisms, as the instrument employed in vital processes. I regard this medium, whether existing in space or in solid bodies, as, beyond all others, the most wonderful form of matter of which we have any knowledge, and that not only the solar emanations, but electricity, magnetism, &c.,

are probably only diverse motions excited in it. If, then, we admit the hypothesis that this æther is a constituent element in all vegetation, living and dead, we should expect it to be highly susceptible and sensitive to the various motions which exist in the external medium, especially that which is transfused throughout the atmosphere in which they are immersed.

But still this æther is only a material instrument. It is not *mind*, nor can it be substituted for mind without contravening the essential distinction between mind and matter. I do not doubt that it is the proximate or secondary cause of a multitude of processes—vital, chemical, and mechanical—in vegetation. It may even be called, with still more propriety than protoplasm, the "physical basis of life." But it is only in itself a material creation, and requires *mind* to make use of it.

Once more :—Much stress is laid in modern scientific theories upon the fact that the "cause" of vegetable life is evidently an internal and not an external one. And this is paraded by some writers as a proof that the Divine Being cannot be regarded as the actual cause of vitality, because they are pleased to regard Him as exclusively *external* to the natural world, and speak of any such direct action upon matter as an "interference" with "inflexible law." The idea, however, which I hold in common with many of the acutest and profoundest thinkers of our own and past ages, is that the Deity is an ever-present and all-pervading Spirit, who works *in* rather than *upon* matter of every kind : though this conception is quite consistent with His being said to dwell in Heaven ; for He is equally "our Father which is in Heaven," as well as everywhere else. He is as truly *in* all material things throughout His infinite dominions, as our spirits are within, and pervade every part of our bodies. This is not Bruno's Pantheism ; it should rather be termed *Empante-theism.* At any rate, I believe it to be the simple truth, and, if fairly realised, would tend in no small degree to reconcile scientific conclusions with Christian doctrine and the plain teaching of Holy Scripture.

(To be continued.)

II. ATLANTIS AND LEMURIA: THE DISTRIBUTION OF LAND AND SEA.*

IT would seem as if every science, how rigorous soever in its methods and teachings, had yet some region where free scope is given to the imagination, and where research and romance seem to blend insensibly into each other. Astronomy has its doctrine of a central sun; physics is barely freed from the haunting presence of the perpetual motion; chemistry is seeking the decomposition of the elements, and biology craves to effect the origin of life from inorganic matter. Geology, physical geography,—if we may use so old-fashioned a term,—and mythology are the joint tenants of a "garden of phantasy," not of the future but of the past; to wit, the assumed islands, or even continents, which are said to have been swallowed up by the ocean. Of these supposed regions one, known as "Lemuria," is by some considered to have extended from Madagascar to Ceylon, or perhaps to Java; whilst another ideal continent which has received no name may, it is thought, have occupied the tropical portions of the Pacific, the scattered island-groups marking out its former mountain-chains. These two lands are not, we believe, the subjects of any popular tradition, nor do they figure in the works of poets and historians. They have been inferred, or at least assumed, by men of science in order to account for certain perplexing facts in the distribution of plants and animals.

Very different is the case with "lost Atlantis." In the days of classical antiquity the former existence of a large island or continent to the westward of Africa was a matter not merely of general belief, but it was referred to in a very decided manner by such writers as Plato, Theopompus, Plutarch, Herodotus, and Diodorus Siculus. All these authors speak of Atlantis as a very large, fruitful, and populous territory, whose inhabitants had come in contact with the nations of Europe and Africa, and had even attempted the subjugation of the eastern continent.

At first sight we are naturally disposed to regard these stories as distorted accounts of America, of whose existence some vague rumours had doubtless reached the so-called

* Oceans and Continents. By T. MELLARD READE, C.E., F.G.S., &c. London: Trübner and Co.

"old world." But to this interpretation there is a fatal objection. If we cross the Atlantic we find among the tribes of Central America corresponding traditions of an island to the *eastward* which had been suddenly overwhelmed and destroyed by an earthquake. This agreement of reports among nations who can scarcely be supposed to have come in contact seems to point to the former existence of a land intervening between Africa and America, and has, not unnaturally, made a deep impression upon the public mind. Further evidence of a confirmatory tendency was not wanting. The unnavigable character ascribed to the Atlantic in the days before the expedition of Columbus might be an exaggerated description of shoals and sand-banks remaining after the disappearance of the ill-fated island, and the present freedom of the ocean from such obstructions would at once follow from a continued subsidence of the area in question. The tract of densely-matted sea-weed westward from the Azores, which Columbus described as scarcely penetrable by his vessels, has been considered as a sort of buoy indicating the former position of this sunken land. The well-known volcanic character of the bed of the Atlantic from the coast of Portugal to the West Indies would afford every facility for the traditional catastrophe. It is further urged that, as shown by the soundings performed by the *Challenger* Expedition, a ridge of land extends from north to south along the middle of the Atlantic, over which the ocean is much shallower than on either side, rarely exceeding 1000 fathoms in depth, whilst on either hand are abysses twice and even three times deeper. There are, further, four places where the ridge rises above the sea level and appears as dry land, viz., the Azores, St. Paul's Rocks, Ascension, and Tristan da Cunha. An upward movement of about 6000 feet would therefore convert much of this ridge into dry land, whilst the islands just mentioned would then appear as lofty mountains.

So far, then, the story of "lost Atlantis" appears very plausible. But on closer examination not a few serious doubts cannot fail to suggest themselves to the enquirer. Let us turn first to the Greek traditions. Plato's account of Atlantis, as contained in his "Timæus," though tolerably circumstantial, is very indirect in its origin. Solon, during his visit to Egypt, is said to have learned certain particulars touching the position of Atlantis and the wars waged by its kings from a priest of Sais. Now, as Plato flourished two centuries after Solon, the first question is how had the tradition been handed down? Again, how had the story reached

Egypt? The rumour is, further, made to take a form flattering to the Greeks, and especially to the Athenians, by whose valour the great Atlantis invasion is said to have been repelled. But this invasion, if it occurred at all, must have taken place at an exceedingly early epoch. Otherwise a man like Solon would have undoubtedly heard of it at home. And it is evidently unlikely, to use the mildest term, that at such a remote time the power of Athens could have been sufficient to oppose an inroad designed for the conquest of Europe and Asia. The remaining Greek writers seem to have merely given echoes of the Platonic tradition.

It has also been pointed out that almost every nation bordering upon the ocean indulges in mythic accounts of the former extent of its territory, and of provinces or adjacent islands submerged in the ocean. As instances we may cite the legends of Lionness, stretching out to the west of Cornwall, or of "Aldland" to the west of Jutland.* Hence the coincidences of Greek and of Toltec tradition become of less value. The European dreamt of lost lands to the westward as did the Mexican to the eastward.

If we turn from human traditions to actually existing things we find facts difficult to reconcile with the existence of the hypothetical island. The Azores, with the exception of one small deposit of supposed Miocene age, in the islet of Santa Maria, are wholly volcanic, a very improbable feature if they had been the mountain-residue of a large island. The small miocene beds just mentioned likewise contradict the supposition that they might have been upheaved by volcanic action since the submergence of Atlantis. Had the Azores been the remnant of an extensive country their animal population would doubtless have exhibited corresponding features. In reality, however, they contain not a single snake, frog, or fresh-water fish, and only such mammals as have been introduced by human agency. The birds, insects, and land-shells, too, are evidently the descendants of stragglers, carried over by storms or currents from the nearest land, and having a strikingly European character. Of the eighteen species of resident land-birds found in the islands, all save three are common in Europe and North Africa. Hence the inference is forced upon us that the Azores are not surviving fragments of Atlantis.

We are thus brought to the threshold, so to speak, of a controversy that is now being carried on as to the permanence or the mutability of the general distribution of land and water on our globe. Have "the great continents and

* Journal of Science, 1876, p. 444.

great ocean basins occupied their present position through all geological time," as is maintained by Mr. A. R. Wallace, Mr. Murray of the *Challenger* Expedition, Professors Dana, Le Conte, and Agassiz ; or has a complete change of land and sea taken place over and over again, as was held by Lyell and many of the elder geologists ? This latter view has been very ably supported by Mr. Reade in the treatise now before us, and is strongly controverted by Mr. Wallace in his " Geographical Distribution of Animals," his " Australasia," and especially in his most recent work, " Island Life." Both authors seem agreed that " every foot of dry land has undoubtedly, at one time or other, formed part of a sea-bottom," but the converse proposition is not admitted. Mr. Reade argues that as "subaërial waste of land is the main source of the *detritus* of which the rocks are built, it follows that where the marine deposits were going on equivalent land must have existed somewhere," and that "the more we *limit* the area of the oscillation of land and sea, the more difficult the explanation of the phenomena of geology becomes."

Mr. Wallace, on the other hand, urges that the stratified rocks of our continents, consisting of sandstones, limestones, and conglomerates, must have been deposited in the shallow water within a comparatively short distance from the shore. He shows that the materials "denuded from the land and carried down as sediment by rivers are almost always confined within a distance of 50 to 100 miles of the coast, the finest mud only being carried 150 or rarely 200 miles." The deposits in mid-ocean consist mainly of " the shells of minute calcareous or siliceous organisms, with some decomposed pumice and volcanic dust." The deep-sea deposits differ in their chemical composition from any strata known to geologists, whilst the littoral accumulations approximate closely to chalk. Strata which had been formed in mid-sea would be characterised by the absence of vegetable remains. Yet if we go back from the miocene even to the palæozoic age we find embedded in the rocks the remains of plants and of animals peculiar to the land, to lakes, or to shallow seas. Further, as we have mentioned above in case of the Azores, the true oceanic islands, remote from the shores of the present continents, have not " preserved any fragments of the supposed ancient continents, nor of the deposits which must have resulted from their denudation during the whole period of their existence." Mr. Darwin contends* that had such continents existed, palæozoic and secondary formations

* Origin of Species, p. 288 (6th edition).

would in all probability have been accumulated from sediment derived from their wear and tear; and these would have been at least partially upheaved by the oscillations of level which must have intervened during these enormously long periods."

Mr. Reade, on the other hand, "is not prepared to admit that the rocks of the earth are all of littoral or shallow-water formation. He mentions that Professor A. Agassiz describes dredging up from over 1000 fathoms in the Gulf of Mexico masses of leaves, pieces of bamboo, of sugar-cane, dead land-shells, and other land-débris which would, if found fossil in rocks, be taken by geologists to indicate a shallow estuary surrounded by forests. It must be remembered, however, that these dredgings took place only fifteen miles from the shore.

Referring to the general flatness of the ocean-bed as another argument used against its ever having been land, he asks "what would Europe or any other continent look like if its configuration were traced only by soundings taken in, say, 3000 fathoms of water? Very probably the same argument would be used to prove that *it* had never been a continent." He considers it highly probable that on the mid-Atlantic ridge there exist submerged peaks of which we know nothing.

There is a consideration which seems at least to show that the main mass of water must for indefinitely long ages have existed in the southern, and the bulk of the dry land in the northern hemisphere; this is, that the now arctic regions appear to have been the original seat of terrestrial life, whilst the great southern ocean seems, according to the naturalists of the *Challenger*, to have been the first starting point of aquatic forms. Now if the bulk of the water had ever been transferred, according to the theory of Adhemar, from the southern to the northern hemisphere, either the proportion of dry land must have been very much reduced or great stretches of land must have existed in parts now covered with deep water.

On closer inspection of the two contending theories it will be found, we think, that a compromise may be effected in perfect harmony with the facts produced on both sides. It is on all hands conceded that every foot of the dry land now existing has been repeatedly submerged, whilst the vast excess of area of the ocean renders the counter-proposition unnecessary and improbable.* But the upholders of the general theory of the permanence of oceans and continents

* Mr. Reade merely argues that *almost* every part of the ocean-bed has been dry land.

make very large concessions. Thus Dr. W. B. Carpenter, in a lecture delivered not quite twelve months ago, considered it possible that a land-connection may have existed between Europe and America, whilst New Zealand, Tasmania, and South America may have been linked together by ridges of dry land, whilst Madagascar may have been similarly joined to Africa and even Asia. The evidence for "Atlantis" as situate between Africa and America did not seem to him satisfactory.

Here, then, we have an admission of the former existence not merely of Lemuria, but of a Pacific continent, though at a higher latitude than has been generally supposed. There could scarcely be a wider departure from the existing distribution of continents than a belt of land severing the Pacific from the Atlantic Ocean.

Mr. Wallace makes concessions somewhat similar, and if less extensive, much more judiciously defined. He thinks that during tertiary times Madagascar was "often probably much larger than it is now," and that to its north-east "there was once a series of very large islands, separated from it by not very wide straits; whilst eastward across the Indian Ocean we find the Chagos and Maldive coral atolls marking the position of other large islands, which together would form a line of communication by comparatively easy stages of 400 to 500 miles each between Madagascar and India."*

Thus, then, we have Lemuria recognised not indeed as a continent, but as an archipelago of large islands!

Turning to the regions of the Pacific we find that the same distinguished author considers New Zealand as having been anciently connected, whether by a continuous tract of land or by a chain of islands, with tropical Australia and New Guinea, "and perhaps at a still more recent epoch with the great southern continent."† Concerning Australia Mr. Wallace remarks also:—"During some portion of the Tertiary epoch Australia probably comprised much of its existing area together with Papua and the Solomon Islands, and perhaps extended as far east as the Fiji Islands, while it might also have had a considerable extension to the south and west."‡ Here, then, we have a goodly continent, largely encroaching upon what is now sea-bed, especially if, as is not improbable, the Moluccas and all land to the east of "Wallace's line" were in connection with Papua.

* Island Life, p. 386.
† *Ibidem*, p. 444.
‡ Geographical Distribution of Animals, i., p. 465.

Let us now see if anything similar can be done for or with "lost Atlantis," so as to reconcile ancient myths with recently discovered facts. Mr. Wallace concludes,—in concurrence with other authorities*—that no inconsiderable proportion of what is now the Gulf of Mexico and the Caribbean Sea was at one time taken up by land. This ancient region "not improbably occupied the space enclosed by uniting Western Cuba with Yucatan, and Jamaica with the Mosquito coast. This land must have stretched eastward to include Anguilla, and probably northward to include the whole of the Bahamas. At one time it perhaps extended southward so as to unite Haiti with Northern Venezuela." Was not this land, seen of course through a mythological medium, the lost Atlantis? True it is more than "some day's sail from Africa." But there is between Africa and the mainland of America no distinct evidence of any other region once existent but now submerged. The late Mr. Belt most decidedly held this opinion.† He suggests further that the Caribs, a warlike, fierce, and enterprising race, who even down to the time of Columbus made long voyages to ravage the villages of the pacific Nahuatls, were a likely people to have invaded the shores of the Mediterranean.

Thus, whilst fully admitting the general permanence of the position of continents and oceans, we see that there are shallows which very probably mark out former extensions of land, and which have disappeared owing to phenomena of subsidence not greater than have been elsewhere established with a tolerable approach to certainty. Whilst an examination of the depth of the seas and of the character of their bottoms indicates such connections as possible, peculiarities in the distribution of animal and vegetable life give almost irresistible proof of their former existence. But whether they were continuous stretches of land or groups of adjacent islands is a question upon which few men of science would venture to pronounce.

* Geographical Distribution of Animals, ii., p. 78.
† Naturalist in Nicaragua, pp. 270 and 365.

III. INDUSTRIAL TRAINING.

By An Old Technologist.

THIS subject is now, under two distinct points of view, drawing the attention of the general public. On the one hand, taking account of the steady growth of foreign competition* backed and fostered by protectionist laws, we ask what are our chances of making head against a number of rivals, all literally hungering and thirsting for the overthrow of our industrial prosperity? Superiority in every branch of manufactures has become for us a question almost of life and death, but many ugly facts seem to show that we have lost not a few of those attributes on which our old reputation was based.

Turning, on the other hand, in a direction apparently quite different, we find that a growing proportion of our people, especially of the rising generation, shrink from manual labour, and prefer the precarious and wretchedly paid career of the clerk to that of the artizan. These two elements of our national position have not escaped the notice of thoughtful men. Still, believing that the last word has not yet been said, I venture to offer a few observations on the subject.

I am far from supposing that the twin-evils which I have mentioned are solely due to any one agency. But among their many causes there is one which is deeply connected with both; I mean the nature of our industrial training, or the manner in which a practical knowledge and a mastery of any useful art has to be obtained. That manner or that process fails, on the one hand, to answer the purpose intended, and on the other hand it keeps aloof many who would otherwise be well fitted for an industrial career. I mean the system of apprenticeship, which has been handed down from the dark ages, and which, though corrupt in itself and quite out of harmony with the times, is recognised by the law, and is enforced by a power which is above the law. The leading features of this institution scarcely need mentioning. Even in its palmiest days it was objectionable, because the pupil was during the course of his training

* It is significant that a statesman of a modern type publicly expressed his pleasure that we had no longer the monopoly of the world's manufactures!

reduced to the position of a serf or a bondsman. The master might be unwilling or unable to teach fully and truly the "art and mystery" to be learnt. The apprentice might, on further experience, find that his own qualifications, bodily or mental, were ill-adapted for the business which he had selected. Yet the tie could only be broken, if at all, at great cost and trouble. Custom has blinded us to the impolicy as well as the injustice of these features, but what should we think of a college which no pupil could leave until his education was complete? A further drawback was the fixed term of years—generally the mystic number seven—imposed alike upon the industrious and idle, upon the lad of parts and the dullard.

In the lapse of ages, however, all the good features of the system have melted away, all the defects have remained and become increased, and certain fresh faults have sprung up. In the olden time the master, who was always personally and practically acquainted with his trade, did, as a rule, give the apprentice thorough instruction in every feature and point thereof. If the latter, from dulness or sloth, did not profit thereby, the fault and the loss were his own. Again, in most of the cities of Europe, the young craftsman when "out of his time" underwent a kind of test examination before experienced members of the guild. If he was found incompetent, the mere fact of his having gone through the form of apprenticeship did not entitle him to set up in business as a master. The long term of years was also not without its justification. The master contracted to board, lodge, and clothe the apprentice, and as the fee—when one was paid at all—was moderate, equity required that he should have the benefit of the services of the latter for some time after they had become valuable. Such was apprenticeship in the days of yore—an institution far from faultless, but perhaps the best that could in those days be carried out, and deserving credit for having trained generation after generation of thorough workmen who took a pride in the quality of their handiwork.

The causes which led to the entire corruption of the system have been fully shown elsewhere, and I will therefore pass at once to its present state. Of its main features there survive merely the legal binding for a fixed term of years, the state of serfdom, and the initial fee, which often reaches to a heavy sum. The personal supervision and instruction on the part of the master have entirely ceased; the youth is turned loose into the workshop, and may, if he is sharp enough, pick up more or less of the details of the

trade. But no one feels personally responsible for his thorough training. Managers, foremen, experienced workmen, *even if willing*, have not time to give him the necessary instructions. And too often they are not even willing. If they are in possession of any especial trade-secret they will not communicate it. It generally happens that in every branch of trade there are certain departments easier than the rest. The apprentice, instead of acquiring a complete knowledge of the whole business, is kept almost exclusively to these easy branches. I have known cases where young men have thus been completely mistrained, and on reaching the end of their term have found that they had their work to begin again.

The moral supervision of the old times has also disappeared no less completely than the industrial guidance, and has given place to systematic initiation in wrong-doing. Among the earliest tasks imposed upon an apprentice in many establishments are to fetch beer or spirits into the workshops contrary to orders, or to watch lest the men are surprised by the manager, when engaged in some piece of peculation, or doing work on their own account with the master's materials. A lesson never omitted in certain trades is to instil into the novice the necessity of wasting the greatest possible amount of time over every job. If a youth finds these and similar pieces of dishonesty repugnant to his principles he is made to feel his serfdom in a variety of manners.

Another feature of old apprenticeship which has been blotted out is the final test of skill and proficiency. All persons who have regularly "served their time" are—in the spirit of British Trades-Unionism—considered equal, and any master who should "call a spade a spade" to the extent of pronouncing an idler or a dolt incompetent would have to bear the consequences. Thus it may be said that modern apprenticeship utterly fails to do what it professes. To say the best of it, it is an initiatory farce which every youth must undergo before he can be allowed to learn a trade in earnest, at the grievous sacrifice of time, money, and moral principle.

I may now ask, who are the parties injured by the apprenticeship system as it now exists? The list is long and formidable. The *bonâ fide* manufacturer (in contradistinction to a class whom I may treat of below) is the first sufferer. He wants skilful, competent workmen, who feel some little pride in their work, and are not always trying how idle, careless, and wasteful they may be without the risk of

dismissal. Such men he can rarely meet with. One of the first lessons which a youth learns on entering the workshop is that merit and demerit are paid at the same rate. He even finds that to excel either in the quantity or quality of his performances is to incur the active ill-will of many of his shopmates. To get through more than a certain amount of work in a given time is considered as a declaration of war against the slothful and the thoughtless. This formal organisation of inefficiency is not merely hurtful to the employer. It tells upon the consumer, who gets inferior articles for his money. It militates against our foreign trade: if purchasers abroad find in every article of British make the stamp of carelessness and inferior workmanship, can we blame them if they send their orders henceforth to France, Germany, America?

Not less deadly is the system to the really clever, industrious, and conscientious workman. He is, according to our modern practice, a mere eyesore and a nuisance to his worthless companions. His very existence is a silent protest against their omissions and commissions.

But the heaviest, the most capital charge against apprenticeship, is that it divides the working classes (in the common acceptation of the term) into two sections, separated by an almost impassable boundary, allowing to the majority no prospect of rise according to merit, and consequently depriving them of all motive for exertion.

In many establishments there exist a small body of skilled hands—foremen over branches, &c.—and a large number of mere labourers. This is decidedly the case in the chemical and tinctorial establishments which the writer has had the greatest opportunity of observing. Between these two classes there exists a gulf fully as wide as that which formerly, in the British army, separated the "officer and gentleman" from the mere private. Just as the officer held his superior position in virtue of purchase-money, so the foreman holds his rank and pay by reason of an apprenticeship premium. If he is attentive, steady, skilful, he may rise to be a manager, or at any rate his salary is sure to be increased. But for the labourer—the "slab," or "mule," as he is called—there is, under ordinary circumstances, no chance of promotion. Suppose that a labourer in a dye-works, by dint of care and attention, became as good a dyer as the foreman of his department, and could turn out, *e.g.*, Turkey-reds unequalled in fire and fastness, would he ever be entrusted with the conduct of that department? Scarcely: it would be said, as it has been said

times without end, "Oh, yes, he is a very useful sort of man in his way, but he has never served his time." This magical formula decides the question. It is scarcely in human nature for a man to aim at excellence when once he knows that his exertions will never command recognition. The consequence is that the labourer takes not a particle of interest in his work, goes mechanically through his round of duties, and obeys the foreman's orders literally. He has no interest in preventing waste or neglect; he cares not a straw for any mischief that takes place, so long as he cannot be held personally responsible, and, as a matter of course, shuts his eyes to all those occasional incidents from which an earnest and thoughtful man might take hints for improvements and inventions. To me it seems exceedingly sad that a large number of the men employed in any of the arts or manufactures should be in such a position,—sad for themselves, sad for their employers, saddest in the end for the nation. Should not the motto of the first Napoleon, "A free career for talent," hold good in the workshop as decidedly as in the camp?

But we may turn to other trades. Among mechanical engineers there are also the two distinct classes; the skilled workmen, who have duly served their time, and the labourers. I could point out a certain establishment of this kind, not 100 miles from Manchester, where there was a labourer by common consent the cleverest man in the yard. If there was any piece of work of exceptional delicacy and difficulty it was placed in his hands. To all this the aristocracy of the trade graciously consented; but he might receive only a labourer's wages. The firm would have been only too glad to encourage him, and secure his services by paying him as a skilled mechanic. Had they made the attempt, however, it would have been voted treason against the sacred rights of apprenticeship, and a "strike" would have been at once declared. It may be asked whether, by thus crushing native talent, we do not fearfully handicap ourselves in our rivalry with foreign nations. Unless I am completely misinformed American manufacturers do not care one straw when, where, or how a clever workman has acquired his skill. The American workman, too, seeks to rise in the world rather by bringing out some useful invention than by enforcing such old-traditional distinctions in the workshop. Such, then, is the influence of apprenticeship upon the artizan.

There is yet a further count in the indictment. The spirit of apprenticeship, in modern times, is one of inveterate opposition to improvement. The inventor, if he can gain a

fair hearing from the capitalist, is at once scouted by the British workman on the plea that, never having "served his time," he is a mere ignorant outsider, and that anything he proposes may, or rather should be, set aside without further scrutiny. It is a great mistake to imagine that "red tape" is confined to governmental or municipal bodies. There is not often found a manufactory without its small "circumlocution" department, and if the proprietor does not indulge in this feature his men rarely fail to make up for the deficiency.

Lastly, but not least, apprenticeship is the true reason why the sons of the poorer middle-class families prefer the semi-starvation of a clerkship to the higher emoluments of the artizan. It is quite a mistake to imagine, as is done by some hasty observers, that this preference is due to any abstract contempt for manual labour or love for "gentility." There is a more tangible hindrance. There is the burden of the premium to be paid down at once, often before it can be ascertained whether the master is really a person to whom the guidance and control of a youth can fitly be entrusted. Above all there is the state of serfdom, not merely in relation to the master, but to every rough about the place who is "out of his time." What this serfdom means to a youth who has been brought up with habits of decency and ideas of self-respect, it would take an abler writer than I am to picture. Suffice it to say that to the average "British workman" (I fear it might be said to the English mind altogether) there is no being so incomprehensible and ridiculous as a poor gentleman. The Spaniard, the Frenchman, the German—I may add the Scot and the Irishman—can appreciate refinement, courtesy, high-mindedness in any position. We are unable to do so, unless to these attributes is added the power to fling shillings to every man who says "It is a dry day." Then, indeed, we touch our caps, and say "That's a real gentleman!" Does the reader now understand why the sons, *e.g.*, of struggling professional men, of "younger sons of younger brothers," and of all whose culture is higher than their means, are compelled to hold aloof from the trades, and must remain so until the guardian imp "apprenticeship" is exorcised?

It may, however, be asked, if apprenticeship is so decidedly hurtful, how does it happen that its formal abolition has not long ago been effected? I answer that the case is very similar to that of our defective patent-law system. The evils are manifold and serious, but they do not lie on the surface. The whole affair, moreover, is one of a plain,

practical character, giving little scope for sensational eloquence, and not fitting into the programme of either of the great political parties. Moreover, the apprenticeship system, with all its failings thick upon it, plays into the hands of two classes, who will most strenuously oppose its reform, or rather its abolition. There are a certain class of employers, both in the productive and in the distributive groups of businesses, who subsist to a great extent upon apprenticeship premiums. Having little real business, little experience, and often little skill, they have not the opportunity to "well and truly teach the craft of" —— to the unfortunate youths whose parents are gulled by their advertisements. In such cases the affair is an empty form, and nothing more. The victim, when his term is out, or rather long before, makes the discovery that his time and money have been spent for nothing. Lawyers will of course remind me that there is a "remedy" for all this, and that damages may be recovered from a master who has not duly instructed his apprentice. This is perfectly true; but what damages can bring back five or seven years wasted at the most critical part of a young man's life? "Premiums" simply enable dishonourable tradesmen not merely to get their work done for nothing, but to be paid for letting some one do it! When the indentures are expired the injured youth is quietly dismissed, and a fresh gudgeon is ensnared in his place. Is it likely that the class who profit so largely by this iniquitous system will be anxious for its reform?

Perhaps a still more obstinate resistance may be expected from the workmen. As a rule, where apprenticeship is most general, trades'-unionism and its interference between capitalist and workmen are most rampant. Throw open a trade to the world, and it will be no longer possible to maintain that law which decrees that the bad workman or the idler shall be as highly paid as the clever and the industrious, and which compels the able to lower themselves to the standard of the most incompetent. It has even been said that to abolish apprenticeship would be to draw the poison-fangs of the unions, thus annulling their power for evil.

It must not for a moment be supposed that I think that a practical training in any art or manufacture can be dispensed with. On the contrary, I would demand in this respect increased thoroughness and a final practical (not verbal) test, without which no person should be competent to exercise the calling in question. But it should be open to any person, no matter how and where he had acquired his knowledge, to come forward and offer himself as a candidate for

the test. All "binding" for any term I would absolutely prohibit. Any member of a trade who had himself passed the test should—on giving proof that he possessed the needful facilities—be licensed to receive pupils for practical instruction. Such pupils should pay as is done in colleges, *i.e.*, not a "premium" or lump sum down, but a quarterly or yearly fee, and should be at liberty to go to another instructor or to another business if either were found, on further acquaintance, to be unsuitable.

Whether this practical training in the workshop should precede or follow a study of the principles of the art or manufacture in one of those colleges which it is hoped will spring up in all our large towns, I would not venture to decide.

IV. COMPARATIVE PSYCHOLOGY.*

ENGLISH literature, from the times of Gilbert White downwards, has been rich in original observations on the habits, the propensities, and the intelligence of the lower animals. Yet until very recently how little have we, as a nation, contributed towards a definite science of the "brute" mind. This poverty is mainly due to the circumstance that we, more persistently than our neighbours, have been intent to go on treating the animal soul and the human soul as two absolutely distinct essences between which no relations of co-filiation or even of similarity are allowed to exist. The general public, including the men of "culture" and "scholarship" as well as the rude and ignorant, assumes that the doings of beasts, of birds, or of insects, are governed by "instinct," *i.e.*, by impulses having their direct origin in the will of the Creator, under the guidance of which each "brute" blindly and almost unconsciously plays its part in the great tragedy of life. It will be granted that such a theory as commonly understood renders observation needless, and any attempt to explain and harmonise facts a mere impertinence. It might, however, possibly have struck the upholders of this doctrine—*un*natu-

* Der Thierische Wille. Von G. H. SCHNEIDER. Leipzig: Ambrose Abel.

ralists, if we may so term them—that even the direct immediate action of the Infinite Wisdom will not be aimless and capricious, but will be based upon definite principles which man may legitimately study and seek to comprehend. Thus to think and to act was not the good pleasure of the "Instinctarian" school. In as far as they condescended to search into animal conduct, will, affection, they strove to bring phenomena into agreement with their preconceived notions of the Divine purposes. Professing to wonder at the goodness and the wisdom of God as displayed in animal life, they rather admired their own cleverness in detecting or inventing cases of contrivance. It may be remembered that a sage of this class fancied he saw the foot of a bee perforated with tiny holes, and immediately pointed out this imaginary feature as a special design for enabling the insect to sift the pollen of flowers!

But even this theory of "instinct" as directly implanted by God might have been turned to good use. Had men tried how far it would account for facts it would at least have given definite direction to observation, just, for instance, as did the doctrine of phlogiston. It would sooner or later have been perceived that animals ocasionally commit serious errors, even in actions essential to the preservation of the individual species. Such instances were put on record by White, though he does not draw the obvious inference that a mistaken "instinct" cannot have its source in Divine inspiration.

Another class, generally naturalists without any philosophical training, have carefully studied the habits of animals, but at haphazard, without any theory at all. This procedure is no less faulty than the setting out with some vague assumption incapable alike of being verified or refuted by an appeal to facts. Too many of our English ornithologists, entomologists, &c., have acted in this manner, and in consequence their researches have not the character of a definite and purposive questioning of nature.

Then, again, there have been speculations put forward by philosophers who made no attempt at observation or experiment. These men evolved out of their own consciousness certain notions concerning animal will and intelligence. Thus, Descartes considered beasts as pure automata, capable of feeling, but unconscious—a hypothesis which scarcely differs from that of the Instinctarians, and which points significantly in the direction of the "unconscious clairvoyance" of Prof. von Hartmann, and of the "unconscious cerebration" of Dr. Carpenter. It is scarcely needful to say that none of

these hypotheses—if we may so call them—throw any light upon the phenomena to be dealt with. We may refer to "unconscious cerebration" the action of the violinist who plays a passage of music and at the same time thinks of something totally different, but not that of the mason-bee who makes and provisions a cell for the offspring she is never to see. We know that with the violinist the production of every note has been the subject of separate and conscious effort, which with increasing practice have become unnecessary. Now in the case of the insect the unconscious action is supposed not to have grown out of any antecedent conscious state. The two phenomena are radically distinct.

On the other hand, Buffon ascribes to the lower animals feeling and consciousness, but not memory, whilst Reaumur and Condillac—the former an observer, the latter not—ascribed their actions to self-conscious purpose, an error which we shall estimate the better if we reflect how great a part of human conduct takes place without any knowledge of its final purpose.

But it is not merely animal psychology which is in an unsatisfactory state. The science of the human mind has by no means reached the position which it ought to have done. In each case the cause of this imperfection is the same: the failure to recognise the fundamental unity of psychic phenomena in man and in beast; the attempt to study facts torn out of connection with the whole to which they belong. We shall make solid and satisfactory progress when, and only when, we set out with the simplest manifestations of feeling and of will in the lowest animals and trace their gradual development up to man. It has long been found that a philosophic study of the structure of the human body is impossible if we repudiate general—or, as it is commonly called, "comparative"—morphology; it is no less certain that the functions of our organs, digestion, assimilation, respiration, and the like, form merely a special province of the physiology of the whole animal kingdom. With the phenomena of mind it is not otherwise. This method of attacking the question is equally essential whether the student considers mind as an immaterial entity superadded to the body of man and beast, or whether with a body of thinkers who, as we must confess are increasing, he looks upon it as a function or property of a "certain chemical compound." The only inquirers to whom comparative physchology is useless, or rather impossible, are those not over-consistent thinkers who, whilst regarding man as a spiritual being, pronounce the

lower animals purely material, a position overloaded with difficulties.

If, then, we believe in the dictum, so often flung reproachfully at men of science, that "the proper study of mankind is man," we must not disdain to begin this study with its very alphabet. For want of such modest and discreet proceeding we have hitherto made much more haste than good speed.

We are mainly led to these considerations by the appearance of a work which will, we believe, mark out a turning-point in the career of animal psychology. The author takes his departure not from a survey of intelligence, but of the will, as the more fundamental faculty. Says he :—"Whether the soul has its seat in the pineal gland or somewhere else; what is the relation between the inner and the outer sense; whether we have any *a priori* ideas; whether things *per se* differ from our perception of them, are questions on which thick volumes have been written and to which a great number of good thinkers have consecrated their existence. But we are only faintly beginning to reflect on the development of the universal motives which have given rise to all intellectual existence."

What are these universal motives, impulses, or, if we please, instincts? Cynical as it may sound to the hasty and the thoughtless, they are, in their origin, simply visceral. All instinctive impulses and all conscious expressions of will subserve either the preservation of the life of the individual or the production and nurture of its offspring. Self-preservation is effected by the acquisition of food, and by defensive precautions and stratagems; the care for the preservation of the species resolves itself into sexual attraction and parental duties, and to these four fundamental principles all the manifold expressions of animal and human will may be reduced. But the nutritive impulse, the craving for food, is the root of all animal instincts, for without food safety is neither possible nor even useful, and reproduction impracticable.* Hunger, therefore, Dr. Schneider maintains, is "the ultimate motive power of all activity and spiritual development."

Can this contention be true? If we look at man as now existing we find that a very large proportion of his activity does not bear even indirectly upon the preservation of the individual or the species, and has, indeed, no material object

* "Sine Baccho et Cerere alget Venus."

at all. Nay, as the highest kinds of exertion, including the discovery and establishment of scientific truth, is not remunerative, we may say that hunger is here a check, not a stimulus. It has often been said that our progress in discovery would be far more rapid if we could train up a caste of thinkers who could dispense with the common necessaries of life. But we are bound to admit that the highest brutes and even the human savage show scant marks of such disinterested and spontaneous activity. The "black-fellow" of Australia, like the cat or the dog when not under the influence of hunger, of fear, or of the reproductive appetite, sleeps or sits idle and objectless. Hence it must be said that if man was placed upon the earth as an intelligent being, Dr. Schneider's fundamental view is false; if, however, our species has gradually been evolved from a lower form of animal life, or even from a state of savagery it is true. At the same time we add "pity 't is 't is true."

As the next step the author divides all animal impulses or "instincts" into four classes: impulses of sensation, perception, conception, and of thought. In the lowest beings the instincts of sensation, excited by touch—by actual contact with some external object—are alone to be traced. In higher forms of life "perceptive" feelings are superadded, by which the author understands such as are produced by distinguishing objects at a distance. Hence they cannot appear until the organs of smell, hearing, and sight have begun to be differentiated. Zoophytes, worms, the lower mollusca, advance to or shrink from an object, only acccording as, on touching it, they experience an agreeable sensation or otherwise. In insects, fishes, birds, and mammalia, the perceptive feelings come into play. Objects desirable for food, individuals of the opposite sex, and, on the other hand, enemies, are recognised at a distance, and the animal in question, without any reflection or idea of an ultimate purpose, acts accordingly. It will be asked why outward objects whether immediately felt, or distinguished afar off, should make a pleasant or unpleasant impression upon any animal? The answer must be sought in the facts of heredity. We—for the perceptive feelings extend up to man—and our semi-human forefathers* have gradually accustomed ourselves to feed upon certain objects, and to avoid others in consequence of their offensive taste or hurtful effects. In consequence the child, as soon as its senses are sufficiently developed, but not before, seizes and eats bodies of the one

* Always supposing that man has been evolved from some lower animal.

class and rejects those of the other—all this without any play of thought, but quite instinctively. The anger of the bull or the turkey-cock at the sight of a red cloth proves how spontaneous and unreflecting are the aversions of animals.

But not merely the touch or the sight of an object may excite feeling and lead to action ; the conception or idea of anything agreeable or disagreeable even in its entire absence produces the same effects in the higher animals and in man. As an instance of such conceptive feelings the author mentions the dread of darkness, of thick woods, and of unexplored caverns, which is now innate in man. This feeling is due to the hereditary conception of dangerous wild beasts, which may approach us unseen in the night, or may lurk in caves and thickets. Hence a vague fear is experienced even where no beasts of prey exist.

Thought-feelings, lastly, are indirect conceptive feelings, and predominate only in man. Hence the author even proposes a zoological classification in which the protozoa, radiata, and most of the mollusca figure as sensation-animals ; the cephalopods and the annulosa as perception-animals ; the vertebrates, with the exception of man, as conception animals ; and man alone as the thought animal. We cannot pronounce this arrangement happy.

The author points out, as the distinction between his position and that of Von Hartmann, that the latter fails to understand how simply instincts may be explained by the inheritance of certain feelings and impulses. He asks "would it not be *piquant* to refer instinct to the fourth dimension which haunts Zöllner's brain ? Whosoever makes this attempt will certainly find readers."

Perhaps the fairest method of deciding on the value of Dr. Schneider's speculations will be to examine their application to certain admitted difficulties in connection with animal intelligence. It has often been asked why a female butterfly deposits her eggs only on such plants which will afford suitable nourishment for the young caterpillars ? The reply is that the sight, the odour, and ultimately the feeling of the proper plant, stimulate her to deposit her ova, whilst if she settles on another plant she experiences no such sensation. It is well-known that the actual laying of an egg depends very much upon the choice of the mother, even in birds. A hen will lay her egg where she sees another egg, or an object closely resembling it in shape, size, and colour. Where she finds no such nest-egg she will roam about as long as possible without laying. In like manner a "painted

lady" butterfly is pleasantly impressed on meeting with a bed of thistles, and attaches her eggs to the leaves. Why she should be thus pleasantly affected on meeting with a thistle we can readily understand if we remember that she and her ancestors have for unknown ages fed upon this plant. That the pupa-state involves complete oblivion of all impressions dating from the larval condition is pure assumption. But these considerations by no means imply that the female butterfly deliberately and consciously selects this or the other plant from the formal conviction that it, and it only, will afford a suitable nourishment for the young brood. The female blow-fly is in like manner led to lay her eggs by a perceptive feeling excited by the smell of putrescible animal matter. How little reason or Divine guidance is concerned in the action appears from the fact that she will likewise lay her eggs on certain flowers which give off a carrion-like odour, when of course the young maggots perish from hunger.

Why, again, do birds always select the most suitable material for their nests, and in general such as cannot readily be distinguished from surrounding objects? Not in consequence of a deliberate selection, but because the perception of this material and of no other is in them part and parcel of the building impulse. The perception of the empty nest or of a single egg is in birds so closely connected with the physiological function of the development of eggs that the former induces, or at least stimulates, the latter, whilst the perception of a sufficient number has the contrary effect. Wild ducks even steal each other's eggs, and some birds will even seat themselves upon the nests of others—a clear proof that the sight of eggs awakes in them a desire to hatch, and that birds sit because it affords them pleasure.

The migration of birds likewise requires no unconscious clairvoyance for its explanation. Natural selection is to some extent here concerned. Those individuals which do not depart in autumn perish, and the species is perpetuated by those only which feel the wandering impulse at the right time. Old birds which have already travelled from Europe to Africa, and have become accustomed to connect want or abundance with certain states of the atmosphere, are urged by conceptive feelings to take their departure. All the phenomena of autumn suggests to them migration just as the sight of eggs arouses the impulse to hatch. Their senses and their intelligence are sufficiently developed to instruct them in what quarter to seek for warmth. In finding their way they have advantages which we men often forget.

Hence migration may be regarded as a complicated result of natural selection, heredity, and perceptive and conceptive impulse. It must also be remembered that birds often set out too early or too late, and consequently suffer; and that multitudes evidently fail to find their way back to their original home, as may be gathered from the want of increase in their numbers.

An interesting fact is cited to prove that birds are formally educated by their parents. Young crossbills are supplied at first with pine-cones which are fully opened, then with half-opened ones, and finally with such as are closed, and are thus gradually trained in the art of finding and picking out the seeds.

The author's explanation of slave-holding among ants does not appear to us satisfactory. He refers this custom to mere perceptive impulse. The plunderers carry strange pupæ into their nests from a mere perceptive impulse, just as a bird will steal the eggs of other birds to sit upon. That the ants thus born in a strange city remain there and work in their accustomed manner need not surprise us.

We think that Dr. Schneider here overlooks the fact that the slave-ants occupy a manifestly distinct and subordinate position, and when dead are treated with less ceremony than the free citizens. It would be very important to make fresh observations on slave-making ants from this point of view.

The further question why any animal should like those things which are favourable to the preservation of the individual or the species, and should shun all that are hostile, scarcely needs answering. Suppose any creature had an especial liking for poisonous food: it must necessarily perish, as multitudes no doubt have done, those only surviving whose taste were in better harmony with the conditions of existence.

Dr. Schneider, whilst tracing many of the habits of animals to direct unconscious perceptive impulses, does not fall into the common error of claiming thought as an attribute of man alone. He gives on good authority instances of complicated action on the part of several of the higher animals, involving formal, conscious contrivance and a calculation as to what a man or other animal would be likely to do under such circumstances. He considers, however, that man only acts on fixed principles. An entire number of the "Journal of Science" would not suffice for the most superficial discussion of half the interesting considerations here brought forward. But the only really appropriate criticism of the work must be conducted in the

woods, or at the aquarium and vivarium, so as to bring the author's views to the test of actual facts. We have not often met with a book of equal value for pointing out to the thoughtful naturalist questions for experimental decision.

That there is here much which we cannot personally approve of is a very secondary point. We scarcely think that the strictures upon Dr. Dohrn, of the Naples aquarium, are justifiable. The author seems to us, further, to go out of his way to sneer at Professor Zöllner and the spiritualist school, with whom he, as belonging to the Hæckelian, or extreme left wing of the Evolutionist army, he has no sympathy. There is also a somewhat gratuitous introduction of the Jewish question, on which Germany is greatly exercised. We hope, however, that this is not the last work of Dr. Schneider's which we may have the pleasure of studying.

V. THE MATERIALISTIC ORIGIN OF THE SEXES.

By Andrew Dewar,
Author of "Origin of Creation."

MATERIALISM is yet in its infancy. Born of human learning, weaned in scientific research, and cradled in the toleration of an enlightened civilisation, its advent marks an epoch in the history of humanity. Should there be fearful shadows in its progress, where loiter grim doubts and gloomy forebodings, these are only consequent to its youth, and the necessary result of the light from a sun whose slanting rays only reach us. But even as the noonday sun chases away the shadows in its splendour, so we are assured that no doctrine in these enlightened days will ever be accepted which does not in its maturity shine on the human race for true knowledge and good.

"All knowledge is our province" said Bacon, and we would be less than men if any phenomenon in nature was considered inscrutable by us, the highest outcome of Nature. Thinking thus, one of the most curious problems is that of the sexes; and the value of the doctrine of Materialism is

apparent when we come to question its cause, for no natural law professes even to offer an hypothesis on the subject.

It may here be asked, what is the doctrine of Materialism? As enunciated by the most advanced physicists, it is that "Matter contains within itself the promise and potency of every form and quality of life." This, it will be correctly said, is only a statement, not a *cause*,—an assumption that requires proof, not a proposition of fact which may be demonstrated with the facility of a problem in Euclid. Granted; but it will be admitted that if we can show how the sexes originate from matter and its inherent properties, Materialism must be more than an assertion. This without further introduction we now propose to discuss.

Taking matter and its properties as the only foundation we can build on with safety, we ask What is Matter?

After long years of experiment and failure we answer this question with a firm assurance in several things:—

First. The Indestructibility of Matter. This involves both the eternity of matter and the eternity of the properties of matter. Nothing exists outside of matter. Nothing but matter and its properties exist. Nothing can be taken from matter, nothing can be added to it. Whatever properties matter may have had, matter must have now; and, *vice versâ*, whatever properties matter has now, matter has always had.

Secondly. Matter is composed of elements of which sixty-four are known. Everything consists of those elements, their combinations, changes, and properties. Whatever form they take now, under similar circumstances they would either in the past or future also assume.

This is the foundation of Materialism, and so far as it goes is perfectly clear and logical. Presuming that no force exists outside of matter, the *properties of matter* must account for every phenomenon in matter, and should they fail the premises fail also, and the fact is made certain that a force exists outside of matter, and ergo that Materialism is dead.

What, then, are the properties of Matter?

Here there is confusion and disagreement. Gravitation, cohesion, and chemical attraction are the three forces which have been popularly supposed to control matter; but when Huxley pertinently asked what these forces were, he found them not forces at all, but mere names or effects of a cause or causes unknown. Even Evolution, from which so much was expected and preached, has fallen into disgrace, and proved to be no force or cause either, but merely an "orderly sequence of phenomena" from some cause or causes unknown. How are we, then, to discover those unknown

causes? If Materialism is true, they must exist; but Materialism cannot be maintained as a doctrine until we show that they do exist and what they are.

We are thus led back to our premises again,—to matter and the elements,—and we say, according to materialistic doctrine, if sex exists in matter now, sex must always have existed. Consequently, if matter was once a sheer chaos, or, as the most daring of physicists assert, a universal fire-mist, then sex in some form or another existed in that chaos or in that mist. As, assuredly, it did not exist in the form of any kind of life we are acquainted with, we are led to ask *if matter does not contain within itself some inherent sexual or dual qualities.* If it does, Materialism is alive; if not, Materialism is dead.

Matter is composed of sixty-four elements, more or less: are these elements all alike in kind, or can we trace a sex or duality in them? Fortunately for our doctrine we can. Although stated by eminent chemists to be of no importance, and made "solely for the sake of simplicity," the elements have long been divided into metallic and non-metallic classes. All the elements belong either to one class or the other. So far success seems to favour us. Doubt is the mainspring of progress, and this doubting of a fact which has long been maintained to be of *no importance* may be the key to open up unknown vistas of research.

It will, however, be conceded in a matter of no importance that this dual classification may be incorrect. This we believe to be the case, for one very important element—hydrogen—is given in every classification among the non-metallic elements, while the element itself is admitted to be metallic; a strange and incomprehensible misplacement. Whether the others are right or not only extensive experiments will determine. With this rectification, however, they are so far correct that the movements of Nature are opened to us as by a miracle. The lock cleared of this obstruction opens readily to the key, and Materialism rules triumphant. We seem premature; how does the duality of the elements solve all mysteries?

The object of this paper was to prove the materialistic origin of the sexes—that sex had its origin in matter. That matter is dual is part confirmation of it, but, like its antitype, we must also prove dual matter to be productive. Two females will not produce, neither will two males. If a production can be formed from the non-metallic elements only, or metallic only, then our theory is false; production should only ensue from the connection or inter-

action of opposite sexes and elements. Chemical analysis in this particular shows that we are right. *No natural pro duction can be found containing the elements of only one class;* both metallic and non-metallic are essential to a formation. In simple laboratory experiments the opposite elements will combine readily with one another, while combination cannot be produced among the elements of either class alone. Even the simplest natural productions, such as air and water, are of dual combinations. Air composed o oxygen, nitrogen, carbonic acid gas, *hydrogen*, &c. Water, composed of oxygen and *hydrogen*, is the great medium also of life and production. Even the old *element*, fire or combustion, can only be produced from oxygen and *hydrogen*, with other opposing dual elements. All rock formations, crystals, stratas, are produced from combinations of the dual elements. All plants and vegetation are of dual formation and dual in sex, while all animals are undoubtedly male and female.

Our premises being thus clear and true regarding the elements of matter, it follows that—as all plants and animals are composed of the same elements, of oxygen, hydrogen, &c., in different proportions and combinations—the conclusion we have been seeking is inevitable, namely, *sex in either animal or vegetable life is derived from and had its origin in the duality of matter.*

What causes dual matter to combine and be productive would lead us into another enquiry as to the origin of life from matter; but this we reserve for future consideration.

ANALYSES OF BOOKS.

Ponds and Ditches. By M. C. Cooke, M.A., LL.D., A.L.S. 254 pp., 12mo. London: Society for Promoting Christian Knowledge.

This little book forms one of a series of "Natural History Rambles." The increased interest felt in all natural history subjects has caused a demand for a class of works giving instruction to those for whom a student's manual would be unsuitable. Such a book is always difficult to write in a satisfactory manner, needing perhaps as thorough aquaintance with a subject as is required for a work of far greater pretensions.

Dr. Cooke has succeeded in writing in a popular and pleasing manner, and yet without in any way sacrificing the interests of science. The first fourteen chapters are equally divided between plants and animals, the fifteenth is devoted to the subjects of collecting and examining. The headings are—Still Waters, Flowering Plants, Plants Without Flowers, Fresh-water Algæ, Desmids, Diatoms, Low-life (Protozoa), Hydras, Fresh-water Polyzoa, Rotifers, Leeches and Worms, Spiders, Mites and Water Bears, Water-fleas, Aquatic Larvæ, and Collecting and Examining. Attention is directed principally to those objects which are likely to be most commonly met with; good figures are given which will aid greatly in the recognition of the various forms of vegetable and animal life.

Those who have had the good fortune to meet the author at one of the excursions of the Quekett Club will recognise his happy style of making himself at home with those who know little or nothing, and leaving them possessed of a considerable amount of practical information. The matter of the very interesting conversations in the field or at the tea-table after the excursion and a good deal more has here been reproduced.

The book is a pleasant one to read, the references to places where fuller details may be obtained are abundant; much information is given relating to obscure plants and animals, such as the algæ, the worms and rotifers, which would have to be searched for through the pages of many books and periodical publications. The book is not only one in every way suitable for beginners, but may be read with profit by those somewhat more advanced in microscopical studies.

Siberia in Europe. A Visit to the Valley of the Petchora in North East Russia; with Descriptions of the Natural History, Migration of Birds, &c. By H. Seebohm, F.L.S., F.G.S., F.R.G.S. London: John Murray.

We have here the narrative of an ornithological tour undertaken in 1875 by the author and his friend J. A. Harvie Brown, to a very scantily known region. Though situate within the Arctic circle the valley of the Petchora offers an interesting field of observation for the naturalist. There were half a dozen species of birds known to visit England whose breeding grounds were a mystery. Of three of these, viz., the grey plover, the little stint, and Bewick's swan, our travellers succeeded in bringing home identified eggs. Two of the remaining, the sanderling and the knot, were found breeding in lat. 82° N., by Captain Fielder, of the Nares Arctic Expedition, and one alone, the curlew sandpiper, is left as a problem for future explorers in the far north. Messrs. Seebohm and Harvie Brown have further added several species of birds to the European fauna, such as the Siberian chiffchaff, the Petchora pipit, the Siberian herring-gull, the Arctic forms of the marsh-tit, and the lesser spotted wood-pecker, the yellow-headed wagtail, and the Asiatic stonechat. The unity of the Palæarctic region is thus confirmed and the arguments in favour of a zoo-geographical separation of Europe from Asia proportionately weakened. But the Author concludes that "as far as the Polar regions are concerned the division into Nearctic and Palæarctic is a purely arbitrary one." Of the 110 species which he obtained 32 breed both in the eastern and western hemispheres. About 17 more belong especially to the eastern polar region, but every one is represented by a species in the western polar regions belonging to the same genus. The watershed between the Yenesay and the Lena appears almost as important a boundary as Behring's Straits. The author notices that though the species of birds within the Arctic circle are few, the individuals may be counted almost by millions, a fact explained by the superabundance of food during the brief summer. For the fruit and seed eaters there is an unlimited supply of berries, "whilst insect-eating birds have only to open their mouths to fill them with mosquitoes." These little wretches, *Culex damnabilis* of Rae appear to abound to a degree unsurpassed, if equalled, in any tropical swamp. Says the author, Our hats were covered with them; they swarmed upon our veils; they lined with a fringe the branches of the dwarf birches and willows; they covered the tundra with a mist." They were told "wait a little and you will not be able to see each other at twenty paces distance; you will not be able to aim with your gun, for the moment you raise your barrel half a dozen regiments

of mosquitoes will rise between you and the sight," We wonder how those writers who seek to represent the mosquito as a sanitary agent, without whose aid "no animal higher than a reptile could have existed,"* will explain its presence in regions where malaria is altogether out of the question? But there is a further difficulty; how has such a taste for blood become developed among a race of beings not one in a million of whom ever tastes it, or even comes within scent of man or other mammal? How is it that the birds, especially when unfledged, escape their attacks?

The author mentions with surprise that he saw three specimens of the common gull (*Larus canus*) perched upon a tall tree, a phenomenon which may be witnessed at home.

Perhaps the most interesting chapter of the work is one written at Heligoland, and treating of the migration of birds. Mr. Seebohm considers that migration is comparatively of recent date. "It is not confined to any one geographical region, nor to any one family of birds, nor can he assume that it will be present or absent in every species of the same genus." He proposes the law that every bird breeds in the coldest country of its migrations. The stories of birds breeding a second time in their winter residence have, he holds, "the same scientific value as the stories of swallows having been found hybernating in caves and hollow trees." He reminds us that some species, such as the robin, the blackbird and the song-thrush, are stationary in England, but migratory in Germany. He suggests that these birds have only recently ceased to migrate in England, so that should our climate remain long enough favourable to their winter abode they will develope into local races with rounder and shorter wings than their continental kindred. He considers that birds were originally resident in the district where they now breed, and that the cause of their wanderings is want of food, not want of heat. But he remarks that it is supposed that many birds leave their winter quarters in southern climates because the heat dries up everything, and lessens the production of insect life." Now in the valleys of Asia Minor, in the gorges of Parnassus, &c., he found insects in profusion in May and June. Why then do insect-eating birds leave those regions in the summer? Not, on his own showing, from lack of food.

Mr. Seebohm doubts the correction between the routes followed by migratory birds and the position of submerged lands. He holds that the desire to migrate is a hereditary impulse to which the descendants of migratory birds are subject in spring and autumn, and which has in the lapse of ages acquired a force almost as irresistible as the instinct to breed in spring. "The direction in which to migrate appears to be absolutely unknown to the young birds in their first autumn, and has to be learned by

* Journal of Science, 1875, p. 225.

experience. The idea that the knowledge of where to migrate is a mysterious gift of nature, the miraculous quality of which is attempted to be concealed under the semi-scientific term of instinct, appears to be without any foundation in fact."

We must here conclude our notice of this pleasant and instructive volume, which we recommend to all lovers of natural history.

History of North American Pinnipeds; a Monograph of the Walruses, Sea-lions, Sea-bears, and Seals of North America. By J. A. Allen. Washington: Government Printing Office.

We have here a valuable and singularly complete monograph of an order whose characteristics, distribution, and synonymy have till lately been involved in much confusion. It is strange to learn that even during the first quarter of the present century, the walrus was allowed to rank with such utterly remote forms as the elephant, the beaver, and the ornithorhynchus. Mr. Allen describes all the species which frequent the seas and coasts of North America. He accepts the division of the order into three families, the Odobænidæ, Otariidæ, and Phocidæ, the last mentioned, or the common seals, being the lowest and most generalised group. Under each species we find given the synonymy and bibliography—in many cases a very complicated subject—the external characters, sexual, individual differences, measurements of skulls, dentition, fossil remains, geographical distribution, habits, products, food, enemies, besides minor points. A very remarkable circumstance is that throughout the order the young are produced on land, and do not enter what is considered their natural element for some weeks. Concerning the sea-lion (*Zalophus californianus*), it is stated that the cubs "manifest great aversion to the water." The young sea-bears (*Callorhinus ursinus*) are at first very feeble and awkward in the water, and that "if put into it before they are five or six weeks old will drown as quickly as a young chicken." It is difficult to avoid the conclusion that the whole order is descended from some terrestrial carnivorous form, and has not yet become perfectly adapted to an aquatic life. Provided the temperature is sufficiently low they do not appear to suffer from a prolonged residence on shore, and in Sweden a young grey seal (*Halichœrus grypus*), has been known to travel at least thirty miles over land. As the food of all the species consists of fish, mollusca, and crustaceans, they are ultimately obliged to return to the sea.

Throughout the order we recognise a very high development of the brain and the nervous system, and most of the species are

sympathetic and affectionate among themselves, sensitive, curious, and capable of domestication. They are even said to be attracted by music—a fact which may, perhaps, throw some light on the classical fable of Arion and the Dolphin. Bearing in mind these attributes we cannot dwell without horror on the description of the seal hunts, or rather massacres, which we find in this volume. We learn that "at other times the young are used as a lure for the capture of their mothers. For this purpose they employ an iron implement having three barbed hooks, on one of which the young seal is impaled alive. The mother hearing its cries approaches it quickly, and immediately embraces it in the hope to free it, but in so doing presses the other barbed hooks into herself, and both mother and young are drawn out of the water together." An authority here quoted describes how, after a seal-battue, "occasionally from out of the bloody and dirty mass of carcasses, a poor wretch still alive would lift up its face and begin to flounder about." The same eye-witness mentions how all the time "hundreds of old seals were popping up their heads in the small lakes of water and holes among the ice, anxiously looking for their young. Occasionally one would hurry across a 'pan' in search of the snow-white darling she had left, and which she could not recognise in the bloody and broken carcass, stripped of its warm covering, that alone remained of it." It is saddening to think of the physical and mental anguish thus inflicted upon harmless creatures at the bidding of greed and fashion. What would be the outcry if one tithe of these cruelties were inflicted in the pursuit of knowledge! The "Devil's Walk on Earth" is incomplete without a verse telling how he smiled at seeing a lady in a seal-skin jacket canvassing for signatures to an anti-vivisection petition.

This work is one of the many valuable contributions to natural history which have appeared in connection with the "Geological and Geographical Survey of the Territories," and for which the Government of the United States is entitled to the gratitude of men of science throughout the world.

Unconscious Memory. A Comparison between the Theory of Dr. Ewald Hering, Prof. of Physiology at the University of Prague, and the "Philosophy of the Unconscious" of Dr. E. von Hartmann. By Samuel Butler, Author of "Life and Habit," "Evolution Old and New," &c. London: D. Bogue.

Above a year ago we had the pleasure of reviewing a work by Mr. Butler, entitled "Evolution, Old and New."* In that book

* Journal of Science, 1879, p. 487.

the author, whilst distinctly adopting the doctrine of organic development as opposed to that of individual and mechanical creation, no less distinctly repudiates "natural selection" as the cause to which the origin of species is due. Although not prepared to endorse this absolute rejection of the principle which in the hands of Mr. Darwin and Mr. Wallace has led or seemed to lead to such splendld results, we did not seek to conceal our approbation of no small part of Mr. Butler's views. Perhaps we might have spoken somewhat more strongly, but, never having been able to relish natural selection, which to us seemed like a glorification, if not a deification of the most painful fact in the universe, we feared to give way to a bias in the author's favour. It seems to us that natural selection, or, in other words, the struggle for existence, is more likely to reduce than to increase the number of species. Mr. Wallace expressly admits * that, "new species can only be formed when and where there is room for them." Hence the less severe the struggle for existence, and the less natural selection is brought into play, the more likely are new species to be called into existence.

In the same work Mr. Wallace further remarks :—"The most effective agent in the extinction of species is the pressure of other species, whether as enemies or simply as competitors.†

In a very similar manner, Dr. H. Behr, speaking of the native vegetation of California, says :—"Its very variation is a proof of a certain want of vitality, for any more vigorous organisation by superseding the weaker ones would have produced originally the monotony developed at present by the immigration of foreign plants." Here again the struggle for existence is held up, not as a multiplier, but as a reducer of the number of species. If such is its function in our time we can scarcely believe that it can ever have played the opposite part and been so largely instrumental in producing the present multitude of organic forms from a few original types. We often forget that out of the almost infinite array of animal and vegetable species the majority are rare. Now if it be true, as most naturalists admit, that a rare species is one that is verging towards extinction, what are we to infer?

Mr. Butler speaks of himself as "one of a small body of malcontents." But though few, perhaps, will join him in his total denial of the claims of natural selection to rank as an agent in the formation of species, those who assign it the sole place are rarer still. It has become almost a truism to say that selection pre-supposes variation ; whence, then, springs the variation?

There is a serious difficulty in the way of Mr. Butler's hypothesis, or rather in that of the elder Darwin, and of Buffon, which he has revived. It is found that a pair of young birds,

* Highland Life, p. 55.
† Enemies or competitors: is not this a distinction without a difference?

brought up apart from the society of their own species, will yet, when their reproductive instinct awakes, construct a nest in exact accordance with the ancestral pattern, and this is very plausibly explained as a result of "unconscious memory." But why does a young male bird, if reared alone, fail to acquire the peculiar song of his race?

There is another problem which we wish to lay before the author. It has been pointed out that the peculiarly disadvantageous positionof the mouth in the shark can scarcely be due to natural selection. Can it have been developed from a "sense of need?"

In the present volume Mr. Butler brings before us the speculations of Prof. Hering, of the University of Prague, which singularly agree with the views expounded in "Life and Habit," and in "Evolution, Old and New." He then gives a version of the chapter on "Instinct," from the "Philosophie des Unbewussten" of Dr. von Hartmann, who refers the migrations and stratagems, the nest building, &c., of birds, and insects to a kind of *clairvoyance.* We might here take the preliminary objection that to explain one unsolved difficulty by another is but a very small service to science. Mr. Butler points out the erroneous character of some of Von Hartmann's assumed facts and of his conclusions, but many more he passes over. One of these errors must be, we should conjecture, the fault of the printer. We read that "an insect of the genus *bombyx* will seize another of the genus *parnopæa* and kill it, without making any subsequent use of the body." We presume that the names should be respectively *Bombus* and *Panorpa.* We quite agree with Mr. Butler in rejecting Von Hartmann's hypothesis, reared as it is upon a doubtful foundation.

The first appearance of life upon our globe has been a difficult question for all thinkers who appreciate the formidable character of the evidence against so-called spontaneous generation, and who are not willing to admit, with Mr. Darwin, an initial creative intervention. Again, it has been said that Dr. Erasmus Darwin refuted himself by consistently extending his theory to plants, which, it is contended, cannot feel a sense of need. Mr. Butler meets both these difficulties by assuming that "there is a low kind of livingness in every atom of matter." "Wherever there is vibration or motion there is life and memory, and there is vibration and motion at all times in all things." I would recommend the reader to see every atom in the universe as living and able to feel and remember, but in a humble way."

Further we read:—As for the difficulty of conceiving a body as living that has not got a reproductive system, we should remember that neuter insects are living but are believed to have no reproductive system. Again, we should bear in mind that mere assimilation involves all the essentials of reproduction, and that both air and water possesses this power in a very high

degree." We must confess our inability to accept this argument. We fail to see in air and water, which are not individualised, any properties which may be fairly interpreted as reproduction. In neuter bees, &c., the sexual organs are abortive rather than non-existent, as is proved by the fact that a difference of diet develops the larva of a working bee into a queen.

If we assume all matter as living, we are still met with the fact that what we call inorganic matter has never within human knowledge been transmuted into even the lowest plant or animal. Thus the difficulty of spontaneous generation remains unsolved.

So far, the work before us may be accepted as an interesting and thoughtful continuation of "Life and Habit" and of "Evolution, Old and New." But it is interpenetrated with polemical and personal matter, which we read with much regret, since, whoever may ultimately prove to be in the right, the interests of Science can scarcely fail to be compromised. On the grave charges here brought against Mr. Darwin it would be unfair to decide until both parties have been heard, and we do not see that a discussion of the personal character of any scientific man falls within our jurisdiction. Still we feel free to declare that had we, when reviewing Dr. Krause's work, been aware of the facts now brought forward, our critique would have been somewhat modified. If an editor or translator interpolates passages in any work, without distinct acknowledgment, he sins both against author and reader. If the additions and alterations were made by Dr. Krause himself, the public ought to have been told that the English version was based, not upon the original text as found in "Kosmos" for February, 1879, but upon a revised and amended issue.

But leaving Mr. Darwin out of the question, the author is but scantily courteous to Mr. Wallace, Prof. Huxley, and naturalists in general. We are struck with the following passage:—"From ladies (?) and gentlemen of science I admit that I have no expectations. There is no conduct so dishonourable that people will not deny it or explain it away if it has been committed by one whom they recognise as of their own persuasion. It must be remembered that facts cannot be respected by the scientist in the same way as by other people. It is his business to familiarise himself with facts, and, as we all know, the path from familiarity to contempt is an easy one." Again:—"Do not let him (*i.e.*, the reader) be too much cast down by the bad language with which professional scientists obscure the issue, nor by their seeming to make it their business to fog us under the pretext of removing our difficulties. It is not the ratcatcher's business to catch all the rats; and, as Handel observed so sensibly, 'every professional gentleman must do his best for to live.'"

That these sayings are very clever and very bitter we do not dispute. But are they justifiable, and what good purpose are they likely to serve? The denunciations which Mr. Butler,

showers upon our "persuasion" do not, however, blind us to the merits of his book, though we believe that not a few passages might be advantageously modified.

The Laws of Health. By W. H. Corfield, M.D. London: Longmans, Green, and Co.

This little work belongs to the series of "London Science Class Books," edited by Prof. G. C. Foster and P. Magnus, and contains much good advice. The author treats successively of health and of disease, with its predisposing and determining causes, of constitution, and of temperaments. Here it must be noted that he regards the nervous temperament as one of a marked tendency to disease and the lymphatic as a condition of strong predisposition to scrofula. He then enters upon the subjects of idiosyncrasies and of heredity. He remarks that "all people who live to a great age have good teeth," and again, "most very old people have been early risers." This may be correct, but do the converse propositions hold good? Do most people who have good teeth and who practice early rising attain a great age? We believe not; early rising is in some parts of England compulsory for the majority of the population, but the duration of life there is far from long. Perhaps, however, we may say that if a man of his own free will and pleasure rises early, it may be regarded as a proof of the possession of a strong constitution, since all persons feel themselves more languid in the early morning than at any other time The author justly condemns open waistcoats, tight-lacing, and high-heeled boots.

In comparing the open fire-places of England with stoves, and giving the preference, from a sanitary point of view, to the former, the author forgets that stoves are not necessarily made of iron, and that those whose outer surfaces consist of glazed fire-tiles are free from the disadvantages to which he refers.

In treating of food Dr. Corfield states that "flesh is more nutritious if eaten raw than when cooked, but less digestible." We do not perceive that he adds in this place the needful caution as to the introduction of entozoa and disease germs into the system through the medium of raw—or what is substantially the same thing—under-done meat. He speaks of the necessity of thorough cooking in case of diseased meat, but many readers may conclude that the precaution is not otherwise necessary.

We consider that this treatise will prove of very great utility.

The Power of Movement in Plants. By Charles Darwin, LL.D., F.R.S., assisted by Francis Darwin. London: John Murray.

It is well known that of late years Mr. Darwin has, with his usual ability and success, attacked the old traditional notion of an absolute distinction between plants and animals. His researches on the fertilisation of orchids, on insectivorous plants, and on the movements and habits of climbing plants, all militate against the supposition of an utterly inert and unconscious character so generally ascribed to the vegetable kingdom. Continuing his investigations he has now shown, by dint of a prolonged course of experiment and observation, that "all the parts or organs in every plant, whilst they continue to grow, are continually circumnutating,"—that is, the point of a growing stem, &c., is found to describe an irregular circular figure. This movement is not uniform, but consists—in some cases at least—of innumerable small oscillations. The phenomena thus produced closely resemble many of the actions performed, as is supposed unconsciously, by the simpler and lower animals. The author remarks that "even among allied plants one may be highly sensitive to the slightest continued pressure, and another highly sensitive to a slight momentary touch."

Mr. Darwin considers that the most striking resemblance between plants and animals is the localisation of their sensitiveness and the transmission of any influence from the part excited to some other part, which consequently moves. It is not, of course, contended that plants possess a brain or other true nervous centre, and a system of nerves by which it is connected with the whole body. But it is, to say the least, doubtful whether such structures exist in the lowest animals, and it is probable that where present they serve merely for a more perfect transmission of impressions and a more complete intercommunication of the several parts.

The author calls attention to the wonderful character of the tip of the radicle, which is remarkably sensitive:—"If the tip be lightly pressed, or burnt, or cut, it transmits an influence to the upper adjoining part of the root, causing it to bend away from the affected side; and, what is yet more surprising, the tip can distinguish between a slightly harder and a softer object, by which it is simultaneously pressed on opposite sides. If, however, the radicle is pressed by a similar object a little above the tip, the pressed part does not transmit any influence to the more distant parts above, but bends abruptly towards the object. If the tip perceives the air to be moister on one side than on the other, it likewise transmits an influence to the upper adjoining part, which bends towards the source of moisture."

Taking these various kinds of sensitiveness into consideration, Mr. Darwin pronounces it hardly an exaggeration to say that

the tip of the radicle thus endowed, and having the power of directing the movements of the adjoining parts, acts like the brain of one of the lower animals, where the brain, seated within the anterior end of the body, receives impressions from the sense-organs and directs the several movements.

The conclusions thus reached are therefore of great importance to the philosophy of Biology, and the work will consequently well repay the study of all sufficiently acquainted with botanical terminology.

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*Geschichte der Mathematischen Wissenschaften.** Von Dr. Heinrich Suter. Zürich: Orell Füssli and Co.

The three parts of this work now before us carry the subject down from the earliest times to the end of the eighteenth century. The author announces that his object has been to produce neither a critical history of mathematics nor a collection of the biographies of mathematicians. The former undertaking would have been, he considers, presumptuous within the available limits, and the latter useless. The history of Science, he justly holds, should be "no mere dry enumeration of facts, no chronological collocation of events, no collection of the biographies of its cultivators or enumeration of their works. It should present a total idea of the structure of Science in its organic development, beginning from the foundation and continuing to the latest stage of completion. Such a history of culture, viewed as the inward spirit of civilisation, he considers the most difficult, but probably the loftiest, task which the human mind can undertake. He holds that of all the sciences Mathematics afford the best opportunity for tracing out the intellectual progress of mankind, from the very severity of its character and the certainty of its movements. In this opinion there is much truth: Mathematics, from its very nature, is exempt from those delusions, false theories, and revolutions which have troubled the evolution of the other sciences. It has had no phases corresponding to alchemy, to quinarianism, to electro-biology. It has refused to ally itself with charlatanism, and its peaceful career has never been checked or diverted by persecution,

The modern neglect of the history of Mathematics he ascribes to the fact that historians rarely feel any interest in exact science.

In the first portion of this work the author naturally takes a somewhat wide scope. Pure mathematics could not then be

* History of the Mathematical Sciences.

distinguished from its applications in astronomy, in geodesy, or in commercial arithmetic. The nearer we approach the present day the more he is compelled to restrict himself to mathematics in the accurate acceptation of the term.

The great controversy as to the respective claims of Leibnitz and Newton to the priority of the invention of the differential calculus is, after a masterly and thorough-going criticism of the evidence, decided in favour of the latter. The author remarks, commenting upon Gerhardt's writings, "They show merely that even Germans can fall into that deplorable fault which we are accustomed to denounce as one of the chief national vices of the French,—unjustly glorifying their own intellectual heroes at the cost of those of other nations.

We regret that space does not allow us to prolong our survey of a work which supplies a hitherto well-marked deficiency in the history of culture, and which we can recommend as worthy the attention not merely of mathematicians.

Bulletin of the United States Geological and Geographical Survey of the Territories. Vol. V., No. 4.

The volume before us affords fresh proof, if such were needed, of the munificence of the Government of the United States in producing works of the greatest value to Science, but which no private person and no publishing firm could undertake in consequence of the loss necessarily involved.

We have here a book of more than a thousand closely printed pages devoted entirely to the bibliography of American ornithology. Under every family of birds we find a reference to every work, journal, &c., in which an account of any species belonging to such family is to be found. In the case of the more important treatises a short summary is added.

Concerning the value of the work to ornithologists there can be but one opinion. Dr. Elliott Coues has fulfilled the laborious duties of compiler.

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

LIFE AND MIND, ON THE BASIS OF MODERN MEDICINE.

To the Editor of the Journal of Science.

Sir,—In the review of the above work, which appeared in your November number, I notice what appears to me a radical misconception of the author's standpoint. Allow me to make a few remarks in defence of his main thesis, as well as in deprecation of strictures on less important points. It seems almost superfluous to say that his antagonism is evidently directed not against Science itself, but against those scientists who confine themselves to special subjects, which, when studied without reference to their bearing on questions of universal importance, can neither conduce to the well-being of their devotees nor increase the sum of human happiness. The happiest life is the highest life. He who combines wide culture with a thoroughly healthy organisation has no doubt a far wider range of enjoyment than the mere savage, peasant, or even the average country squire; but how many of our modern *savans* answer to this description? Indeed the generally prevailing timidity and reticence which has led to a sort of scientific "Concordat" with religion, and rendered an "outspoken" book like "Life and Mind" so remarkable, must be abhorrent to a manly and truth-loving nature. So far is Dr. Lewins from being a foe to Science that the foundation of his thesis is identical with that of modern Physics and Biology.

Since the demonstration by Newton that Force is an immanent, inalienable, universal attribute of Matter, there has been no excuse for animistic hypotheses. Life is but one of the Protean manifestations through which this all-pervading activity is manifested. That heat, light, and explosive energy should be evolved from the chemical union of two apparently inert substances, is quite as wonderful and inexplicable as that a combination of unconscious atoms should form a conscious organism. It is no speculation, but an ascertained fact, that the healthy or diseased state of thought and sensation depends upon a corresponding

condition of the brain and nerves, and that there is no immaterial agent which can supply the deficiencies of these material organs.

Every medical practitioner is now a practical, if not a theoretical, materialist. For the baneful effect upon Science of the opposite theory I need only refer to the closing, by Constantine the Great, of the Asclepions, or temples of Æsculapius, which had been converted, by the influence of Hippocrates and his rivals, into schools of scientific medicine. No doubt hospitals were founded in their stead; but the result was the substitution, throughout the Byzantine Empire, of ignorant relic-mongers for trained physicians.

Since Hylozoism affords the only position from which we can successfully deal with Nature, we must not hesitate to apply its conclusions to the "Supernatural." It is equally impossible to prove and to disprove the existence of an "Infinite Mind;" but the doctrine of Omnipresence makes Pantheism a logical necessity, and the Pantheos must be the Substance or Noumenon of soul and body alike, which cannot therefore be distinct entities. Man is, on this hypothesis, a part of God; but the Divinity actually adored (like all ideas and sensations, like the visible world itself) is a part of man. All adoration therefore "becomes pure Hylotheism and self-worship." Since mind is but a function of the brain, personal immortality is clearly impossible; but since we thus lose not only heaven, but hell, and no longer believe that the vast majority of mankind are doomed to "æonial" torture, it can hardly be considered that our prospects have altered for the worse. Death is no longer regarded as a curse, but as a necessary link in the chain of life; and though the present Cosmos may not be immortal, the matter of which it is composed must be so, for every atom must retain its primal energies undiminished through all eternity. The death of religion will form a necessary era in the life of humanity; and if nothing but a temporary though fearful humiliation, such as has befallen other nations, can arouse England from her lethargic hypocrisy, no true patriot should shrink from the ordeal. Evil is but good in the making; and here I may appropriately refer to the quotation from Faust, upon which your reviewer animadverts. Throughout the drama Mephistopheles really is, as he mockingly describes himself,—

> "Ein Theil von jener Kraft,
> Die stets das Böse will und stets das Gute schafft."

He is evidently so regarded by "der Herr," in the speech beginning—

> "Du darfst auch da nur frei erscheinen,
> Ich habe deines Gleichen nie gehasst," &c.

Faust, whose aspiring nature finds no satisfaction in the dull

round of pedantry which contents his famulus Wagner, is represented as reduced to utter despair, and meditating suicide, *before* the arrival of his fiendish visitor. He dies in the joyous anticipation that his life will be crowned by the sight of a free people dwelling in a free land, which he himself has reclaimed from the sea.—I am, &c.,

C. N.

[We are perfectly ready to draw a distinction between Dr. Lewins and "Thalassoplektos." The theses of the former gentleman are a subject for legitimate scientific examination, and we think all who really value truth would like to see the question of Animism or Hylozoism fairly and fully discussed. The remarks of "Thalassoplektos" on scientific men in general, and on Faraday in particular, seem to us incapable of defence, or even of palliation.—Ed. J. S.]

UNPLEASANT ALTERNATIVES.

To the Editor of The Journal of Science.

Sir,—Mr. Hingston, in his "Australian Abroad," describes certain feats which he saw performed by jugglers in India. Certain balls, marked with numbers, were thrown up into the air, where they disappeared out of sight. On any of the spectators asking for a certain number, that one, and no other, reappeared and fell into the circle. It is difficult to account satisfactorily for such phenomena. We cannot suppose that Mr. Hingston is knowingly and consciously relating an incident that never took place. We cannot imagine that these jugglers are acquainted with unknown natural forces or with novel applications of such as are already known, but of which our greatest physicists are ignorant. As little can we assume that superhuman beings hold themselves in readiness to execute the orders of these jugglers, especially as, if the latter have such allies in their service, they might turn their powers to far more profitable account than to collecting a few rupees from wondering spectators. Nor, if we consider that the performance took place in the open air, is it easy to conceive of any manner in which Mr. Hingston's senses might have been deceived. Is not this a matter worth scrutiny?—I am, &c.,

Verifier.

THE ANTI-VIVISECTION AGITATION.

To the Editor of the Journal of Science.

Sir,—You were only too true a prophet when, in 1876, you warned biologists and the medical profession not to hope that the Bill then under discussion would be accepted as final by humanitarian fanatics. It appears that, although it is doubtful whether time can be found by Government for the consideration of so vital a question as patent-law reform, yet a Bill for the total suppression of vivisection is to be introduced. We have allowed fanaticism and organised ignorance to steal a march upon us, and the Biological Research Defence League is still *in nubibus*. We must therefore wait no longer. Will it not be possible to procure formal protests against any further restrictions from all the scientific societies, London and provincial, which in any way concern themselves with the study of animal life; from the medical faculties of the Universities; from the Royal Colleges of Physicians and Surgeons of England, Scotland, and Ireland, &c.? Should not petitions against such restrictions be placed for signature at the offices of the medical and scientific journals? I have no doubt that Dr. Cameron, M.P., will undertake to deliver such petitions and to support their prayer. Unless we are active every experiment upon a living animal, which some sentimentalist may think proper to call painful, will be branded as a crime, and punished far more severely than torture inflicted upon animals out of wantonness or for amusement.—I am, &c.,

Graduate.

"MODERN CYNOLATRY."

To the Editor of the Journal of Science.

Sir,—I beg to enclose you a cutting from the "Boston Journal of Chemistry" for December, 1880, which seems to me strongly to confirm the position taken by your able contributor.—I am, &c.,

Anti-Anubis.

"*Sheep versus Dogs.*

"There can be no doubt that the keeping of sheep by farmers in New England is a profitable industry, but the great difficulty

in the way of success is the peril from dogs. Our towns are full of worthless dogs, and it is found impossible to prevent their cruel slaughter of our sheep in pastures. A few weeks ago a neighbour placed one hundred sheep on a farm near to Lakeside, and in one night twenty-seven of them were cruelly bitten, killed, driven into the lake, or drowned. Several of them swam across the lake, and were found exhausted in the woods on the opposite shore. For all this damage he will receive only about one hundred dollars from the county. We need more stringent dog laws. The license should be raised to five dollars for keeping a dog, and the penalty for not obtaining a license should be greater than now. If farmers will unite in securing from the legislature more stringent laws, sheep raising can be resumed in New England with profit."

SCIENCE IN THE WITNESS-BOX.

To the Editor of the Journal of Science.

SIR,—The following extract from the "Magazine of Pharmacy" may be of some importance to your readers, since it evidently applies not merely to the medical profession, but to chemists, engineers, microscopists, and other scientific men whose unpleasant duty it may ever become to give evidence in a court of justice:—

"A high compliment has been paid by Mr. Justice Stephen to the medical profession of Leeds. It appears that Dr. Allbutt, of that town, and Mr. Stotter, of Wakefield, gave evidence recently at the Leeds Assizes, before Mr. Justice Stephen, relative to the injuries which a young lady had received in an accident on the Lancashire and Yorkshire Railway. At the close of the case his lordship said that the medical evidence of these two gentlemen was a pattern of what such evidence should be. He was in the habit of hearing medical evidence in all parts of the country, and Leeds was the only town where he never heard those unseemly disputes between the legal and medical professions which occurred constantly at other places. Here there was a certain number of gentlemen, the leaders of the medical profession in the Great School of Medicine in Leeds, who had set an admirable example for many years past of truth and candour and straightforwardness in the witness-box, and he was happy to see that their example was being followed by the younger members of the profession. When a man really tried to tell the truth, the whole truth, and nothing but the truth, in plain and simple language, notwithstanding what consequences might be drawn from it, or

whether he was called on one side or the other, bullying in court and things of that kind ceased at once."

It seems to me that this "compliment to the medical profession of Leeds" is in reality a blow aimed at their colleagues in other parts of the kingdom. Mr. Justice Stephen evidently seeks to convey the impression that "bullying in court and things of that kind" are not due to the discourteous manner in which counsel take advantage of the license allowed them, but to a want of "truth and candour and straightforwardness in the witness-box." I must protest most emphatically against this assertion. The object of counsel is, of course, to prevent "the truth, the whole truth, and nothing but the truth" from being told, if such truth bears against their clients; and if they cannot hinder its utterance they seek, at any rate, to bewilder the minds of the jury and to insult the witness. I consider that Mr. Justice Stephen, in his remarks, has grievously wronged the medical profession and other men of science ever called on as experts.—I am, &c.,

B. P.

NOTES.

An eminent physician of Dublin, referring to "those erratic medical hybrids, the lady doctors," very justly remarks, "There are some masculine women just as there are some effeminate men. Neither are good types of their kind; and it needs no serious argument to prove the futility of any attempt founded on such exceptional cases, on the part of either sex, to fill the place and assume the functions of the other."

According to the Boston "Herald," an establishment for the manufacture of "bogus diplomas" has been discovered in that city. It is supposed to have manufactured about one hundred doctors, at prices varying from 100 to 145 dollars each.

According to the "Medical Press and Circular," certain Scotch professors—in particular Prof. Blackie and Prof. Charteris, both of Edinburgh—have been indulging in the customary onslaught on Physical Science, on account of its alleged materialistic tendencies.

An entomologist of Elbeuf, M. Levoiturier, according to "Les Mondes," has succeeded in distinguishing wools of different growths by means of the coleopterous insects found in the bales. In Australian wool he has identified 47 species of insects, 52 in South African, 30 in that from Buenos Ayres, 16 in Spanish, and 6 in Russian. As the origin of a sample of wool is a matter of considerable importance to the consumer, this is an unexpected service which Entomology has rendered to commerce.

Prof. Klebs, of Prague, has found in subjects dead of typhoid fever peculiar microbia, of about 80 micromils. in length and 0·5 to 0·6 in breadth. They are chiefly found in the parts most affected by the disease, and are absent in the bodies of those who have died from other causes.

The Copley medal this year has been awarded to Prof. J. J. Sylvester for his mathematical researches: one of the royal medals has been decreed to Prof. Jos. Lister, F.R.S., for his investigations on the antiseptic system of surgical treatment, and the other to Capt. A. Noble, F.R.S., for researches on the action of explosives. The Rumford medal has been voted to Dr. W. Huggins, for investigations in astronomical spectroscopy; and the Davy medal to Prof. C. Friedel, of Paris, for chemical discoveries.

According to the "Medical Press and Circular," a memorial in favour of cremation, numerously signed by physicians and surgeons, has been presented to the Home Secretary.

Prof. H. L. Smith, of Kenyon College, in the new American periodical "Science" (1880, vol. i., p. 26), remarks upon difficulty of effectually preserving dry mounts; the appearance known as *sweating* sooner or later taking place, and spoiling—or at any rate impairing—the view of the contents of the cell. Prof. Smith has tried mounts of nearly every kind, and uniformly with the same result. Mr. F. Kitton, in writing on the same paper, says that he is unable to suggest a remedy. All experiments with the most varied materials have failed. The fault seems to lie in the cover glass itself, the same "sweating" frequently taking place in the lenses of eye-pieces.

According to G. H. Schneider, vital processes are distinguished from mere chemical combinations by the circumstance that they lead to a final phenomenon, which again occasions a repetition of the whole series of phenomena of the course of life.

It appears that the promised subscriptions to the Liverpool University Fund amount to nearly £100,000.

The next meeting of the French Association for the Advancement of Science will take place in Algiers, April 14th, 1881.

As a practical comment upon the article "Cynolatry," in our December issue, it appears, according to the "Medical Press and Circular," that about twenty persons were bitten by a rabid retriever in the outskirts of Leeds, in one day!

According to Dr. C. C. Merriman, insectivorous plants are more numerous and more perfectly developed in the Central Lake regions of Florida than elsewhere.

Dr. Chervin has studied the medical geography of France, with especial reference to infirmities which disqualify for medical service. The regions most affected are the north-west, the centre, and the south-east.

A Mr. Plimsoll thinks that he has discovered a plan by which a great proportion of coal-mine accidents may be prevented.

The rhinoceros discovered in 1877 in Siberia proves to be a specimen of *R. Merckii*, a species intermediate between *R. antiquitatis* and the kinds now extant, but more nearly approaching the former. Fossil remains of this form have hitherto been found only in Western and Southern Europe, and it is therefore interesting to find a specimen with the skin, hair, &c., well preserved, in the very coldest part of Siberia.

"Les Mondes" describes a spectroscope specially devised by M. Lamansky for the study of the phenomena of fluorescence.

We regret to learn the death of Dr. W. Lauder Lindsay.

NINETEENTH YEAR OF PUBLICATION.

THE

JOURNAL OF SCIENCE,

AND ANNALS OF

ASTRONOMY, BIOLOGY, GEOLOGY, INDUSTRIAL ARTS, MANUFACTURES, AND TECHNOLOGY.

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PRICE ONE SHILLING AND SIXPENCE.

THE

JOURNAL OF SCIENCE.

FEBRUARY, 1881.

I. THE EARLY PRACTICE OF MEDICINE BY WOMEN.

By Professor H. Carrington Bolton, Ph.D.,
Of Trinity College, Hartford, Connecticut.

In attempting to sketch the history of the entrance of women into the medical profession we find the earlier periods obscured by a meagreness of material and a lack of sequence which our superficial researches have failed to supplement.

Isolated cases of gifted women attaining notable surgical skill and successfully pursuing the divine art of healing are recorded at various epochs in the history of the intellectual development of woman, but they occur at long intervals of time and in widely scattered chronicles. In the following pages we have not undertaken to present an exhaustive history or catalogue of female practitioners of medicine; we have simply collected a few scattered notices, and moulded them into an outline to be hereafter filled up by a more competent hand.

These notices refer to the earlier history only, and by earlier history we mean the period prior to the establishment of medical schools for women, and to the present movement for their higher education. From the earliest times women have successfully grappled with a most difficult branch of medical science, gynecology, but long-existing and deep-seated prejudices prevented an extension of their practice, and, save in exceptional cases, they were forbidden both the acquirement of accurate and systematic knowledge and the exercise of their chosen vocation. So long as the practice of medicine formed a part of the priestly functions, as in

ancient Egypt, the crafty guardians of superstition sedulously concealed their superior knowledge from an ignorant and credulous people, and especially from women. Yet the story of the birth of Moses shows that female gynecologists were not unknown to the Egyptians.

At a later period the Greeks thought to add dignity to the practice of medicine by forbidding it to slaves and (forsooth!) to women. During the Middle Ages, when every branch of Science was more or less dishonoured by degrading superstitions, we find women, as well as men, yielding to their influence and exercising the double calling of sorceress and healer of the sick; nor has the intelligence of the common people even in the nineteenth century reached such a height as to render the business of medical clairvoyant nugatory and profitless.

The invention of medicine was almost universally attributed by the ancients to the gods, and it is a curious fact that in both Egyptian and Grecian mythology we find female deities occupying important relations to the healing art. To the Egyptian deity Isis, the wife and sister of Osiris, peculiar medical skill was attributed, and a multitude of diseases were regarded as the effects of her anger. According to tradition she had given unequivocal proof of her power by the restoration of her son Orus to life. She was the reputed discoverer also of several remedies, and even as late as Galen the Materia Medica contained several compounds which bore her name: thus, in the symbolical language of the Egyptian priestly physicians, the vervain was called the "tears of Isis."

According to the annals of Grecian mythology, Hygeia, daughter of Æsculapius, the god of medicine, was worshipped in the temples of Argos as the goddess of health. In art, Hygeia is represented as a virgin wearing an expression of benevolence and kindness, and holding in one hand a serpent which is feeding from a cup in the other. She was regarded as the goddess both of physical and mental health, thereby personifying the aphorism "Mens sana in corpore sano." The Greeks also ascribed medical power to Juno, who, under the name of Lucina, was held to preside over the birth of children; and to Ocyroe, daughter of the Centaur Cheiron, who was renowned for his skill in surgery and medicine. The sorceresses Medea and Circe were said to make use of herbs in their enchantments and for the purpose of counteracting the effects of poisons. These and similar fables probably preserve in allegoric form facts connected with the practice of medicine by women in the remotest antiquity.

The writings of Homer have been examined to ascertain his testimony, but, with the exception of slight reference to woman's part in nursing wounded warriors, he contributes nothing to the subject under consideration.

The learned among the Celts, the Druids, were at the same time judges, legislators, priests, and physicians. By persuading the people that they maintained intimate relations with the gods, they succeeded in imposing their authority on the ignorant masses. "Their wives, who were called *Alraunes*, exercised the calling of sorceresses, causing considerable evil by their witchcraft, but caring for warriors wounded in battle. They gathered those plants to which they attributed magic virtues, and they unravelled dreams." (Dunglison.)

The first female practitioner who received a medical education appears to be Agnodice, a young Athenian woman who lived about 300 B.C. To satisfy her desire for knowledge she disguised herself in male attire, and, braving the fatal results of detection, dared to attend the schools of medicine forbidden to her sex. Among her instructors was numbered Herophilus, the greatest anatomist of antiquity, and the first who dissected human subjects. After completing her studies, Agnodice preserved her disguise and practised her chosen calling in the Grecian capital with great success, giving particular attention to the diseases of her own sex. The physicians of Athens, becoming jealous of Agnodice's great reputation and lucrative practice, summoned her before the Areopagus, and accused her of abusing her trusts in dealing with female patients. To establish her innocence Agnodice disclosed her sex, and her persecutors then accused her of violating the law prohibiting women and slaves from studying medicine, but the wives of the most influential Athenians arose in her defence, and eventually obtained a revocation of the law.

The laws and customs of the Romans, as well as of the Greeks, were antagonistic to the entrance of women into the medical profession, yet Galen, Pliny, and others have preserved the names of a few distinguished in the art of healing:—Phænarete, the mother of Socrates, Olympia of Thebes, Salpe, Sotira, Elephantis, Favilla, Aspasia, and Cleopatra. Of these, details are generally wanting. Scribonius Largus writes of an "honest matron" who cured several epileptic patients by an absurd remedy, and mentions having purchased of a woman a prescription for the cure of cholic, the composition of which she had learned in Africa. Why Aspasia appears in this connection is not perfectly clear;

the talented wife of Pericles, renowned as "a model of female loveliness," was doubtless too involved in affairs of state to undertake the absorbing cares of the medical profession. Cleopatra, the accomplished and luxurious Queen of Egypt, of whom so many marvels are related, is named among those women possessed of medical skill; she is reported to have compounded cosmetics, and to have written on the art of preserving beauty; but this statement is probably no more worthy of credence than that of the infatuated alchemists of the Middle Ages, who would persuade us that Cleopatra was the fortunate possessor of the philosopher's stone and of the universal solvent. In proof of the former statement they point to her personal attractions, unchanged by increasing years, and to her immense wealth; in proof of the latter they rely with confidence on the well-known fable of the solution of the costly pearl at the extravagant banquet to Marc Antony.

In a Roman lady named Fabiola we find an early predecessor of Florence Nightingale. She was of the illustrious house of Fabius, and was celebrated in the fourth century for piety and charity. She is to be held in grateful remembrance as the founder of hospitals in Italy, and she is said to have personally nursed the sick at Ostia. The establishment of hospitals is commonly credited to the Emperor Julian, 362 A.D., with whom Fabiola was contemporary; perhaps she took an active part in the humane movement, and held a position analogous to that of lady manager in modern times.*

Half a century later lived a woman justly distinguished for combining in one person a high degree of female loveliness, womanly virtue, and intellectual strength: though not occupied with the art of healing, we cannot pass in silence the accomplished Hypatia. Born at Alexandria in the latter part of the fourth century, the daughter of Theon, an eminent mathematician and philosopher, she soon excelled her father in these branches of learning. After profiting by profound studies under celebrated masters at Athens and Alexandria, she publicly taught philosophy at both these centres of culture. Gibbon writes of her—"In the bloom of beauty and in the maturity of wisdom, the modest maid refused her lovers and instructed her disciples." On Hypatia's inhuman murder, at the instigation of the jealous Cyril and his fanatical followers, it is not here necessary to dwell.

* Celsus, who wrote in the reign of Augustus (A.D. 1), mentions large hospitals where patients were treated with specific medicines. (Milligan's Ed., p. 14.) Seneca also refers to them as "valetudinaria."

The practice of medicine by women obtained to some extent during the Middle Ages. Under the influence of Mohammedan rule women were placed in excessive isolation, and it is not surprising to find under these circumstances that certain women were skilled in attending to the requirements of their own sex. Thus Albucasis, of Cordova, one of the most skilful surgeons of the twelfth century, secured the services of properly instructed women for assistance in operations on females in which considerations of delicacy intervened. Avicenna, also, writing of remedies for diseases of the eyes, mentions a collyrium compounded by a woman well versed in medical science. On the whole, however, the number of women instructed in medicine among the Arabs was very small, owing possibly to the inferiority to which women were condemned by Eastern usages.

In Christian countries the nuns as well as the priests attended to the healing of the sick as an act of charity and piety. Abélard, in the twelfth century, permitted the practice of surgery to those of the convent of the Paraclete, over which Héloïse presided. The most celebrated of the learned nuns was Hildegarde (A.D. 1098 to 1180), abbess of the convent of Rupertsberg, near Bingen on the Rhine. She compiled a sort of Materia Medica, which comprises a variety of superstitious remedies. Radegonde, of France, the founder of a convent at Poitiers (died 587), the pious ascetic Elizabeth of Hungary (died 1231), Hedwigia, wife of Henry the Bearded, and other women who devoted themselves to the care of the sick, may be properly regarded as praiseworthy exemplars of Christian benevolence rather than educated practitioners of medicine.

In the famous school of medicine established at Salernum by Benedictine monks, in the eleventh century, we find women taking an important part. Ordericus Vitalis, in his "Ecclesiastical History" (written about 1130), relates that an abbot eminent in natural sciences, and especially distinguished in medicine, visited Salernum in the year 1059 for the purpose of discussing medical topics, and found no one erudite enough to reply to his propositions save a certain woman of great learning. This woman he does not name, but she is supposed to be the same as Trotula of Ruggiero, whose reputation at that period was world-wide. At Salernum women were engaged in the preparation of drugs and cosmetics, and in the practice of medicine among persons of both sexes: such were Abella, author of two medical poems; Costanza Calenda, the talented and beautiful

daughter of a skilful physician, under whose instructions she attained to a doctor's degree; Mercuriade, author of several treatises; Rebecca Guarna, Adelmota Maltraversa, and Marguerite of Naples, who obtained royal authority for practising the medical art.—(Beaugrand, in "Dict. Encyc. Sci. Médicales.")

The ancient and honourable universities of Italy were, we believe, the first to recognise the capacity of women to give instruction of a high character. The University of Bologna, founded in 1116, was attended in the year 1250 by ten thousand students, engaged in the study of jurisprudence, of philosophy, and of medicine. "Here was first taught the anatomy of the human frame, the mysteries of galvanic electricity, and later the circulation of the blood." Here, too, were the earliest successful experiments in admitting women to occupy professorial chairs, for a long line of female professors taught in many departments of learning.*

As early as the thirteenth century two women were numbered among the eminent professors of the University of Bologna—Accorsa Accorso and Bettisia Gozzadini; the former held the chair of Philosophy, the latter that of Jurisprudence. In the fourteenth century the lovely and learned Novella d'Andrea, daughter of a distinguished lawyer, often took her father's place in the professorial chair, and instructed his students in law. Of Novella it is reported that she was so beautiful that she lectured behind a curtain, "lest, if her charms were seen, the students should let their young eyes wander over her exquisite features and quite forget their jurisprudence." The rival University of Padua, founded in 1228, had also its female representatives. Of these the most distinguished was Elena Lucrezia Cornaro. This interesting woman was born at Venice, June 5, 1646, and at a very early age exhibited an extraordinary capacity for acquiring languages. She was familiar with French, Spanish, Latin, Greek, and Hebrew, besides her native Italian, and had some acquaintance with Arabic. While endowed by nature with poetical and musical talents, she possessed at the same time great perseverance and capacity for serious studies, and discoursed eloquently on abstruse topics in philosophy, mathematics, astronomy, and theology. At the age of 32 the University of Padua conferred upon her the degree of Doctor of Philosophy. Cornaro seems

* According to Madame Villari, whose papers on the "Learned Women of Bologna" furnish us with many of the succeeding data, there is to the present day no law preventing women from graduating at Italian universities or taking professorial positions.

never to have held any public position, being naturally of a retiring disposition, and moreover exceedingly devoted to the order of St. Benedict. After acquiring a European reputation she died at the comparatively early age of 38 (1684).

The beginning of the following century witnessed the birth of one of the most gifted women the world has ever seen. Laura Caterina Bassi was born at Bologna, October 31, 1711. She was the daughter of a distinguished lawyer and *littérateur*, and at a tender age manifested extraordinary precocity, being able while still a child to translate fluently most difficult Latin and Greek. Encouraged by her father, she pursued her studies under the guidance of eminent masters; she learned physiology and medicine with the erudite physician Gaetano Tacconi, mathematics with Manfredi, and natural philosophy with the disciples of Gassendi, and she astonished these profound philosophers by her talents. Laura Bassi studied for the pure love of knowledge, and had no ambition to seek public honours, but, to gratify the pardonable pride of a father as well as the earnest desire of her instructors, she consented to support a philosophical thesis before a learned audience of professors. This event took place on the 17th of April, 1732, before she had reached the age of 21 years. The occasion was made one of festivity by the whole city, who turned out to do her honour; the assemblage was presided over by two cardinals —Lambertini, afterward Pope Benedict XIV., and Grimaldi. According to custom her thesis was opposed by seven learned men; to these she replied in elegant Latin with great success and amid the applause of the distinguished audience. A month later the degree of Doctor was conferred upon her, and she was honoured by a position in the Faculty of Philosophy. The Senate subsequently bestowed upon her the chair of Physics, and commemorated the event by striking a medal which bore her own portrait. She held the professorship twenty-eight years with marked success, paying particular attention to mathematics and physics, also to *belles-lettres*. Several academies of learning elected her to membership. In 1738 she was married to J. J. Veratti, a physician, and became in the course of time the mother of twelve children. A learned French *littérateur* who visited Bologna in her day thus describes her appearance:— "Laura Bassi has a countenance slightly marked with small-pox, but of a sweet and modest expression; her black eyes are sparkling, yet tranquil, and she is serious and composed in demeanour without affectation or vanity. Her memory is tenacious, her judgment sound, and her

imagination active." She died in the year 1778, at the age of 67.

Laura Bassi does not seem to have pursued medical studies, and certainly never engaged in practice; but any account of the gifted women of Bologna who laboured in this direction would be incomplete without a brief notice of Madame Veratti.

Contemporary with this interesting woman lived another, less gifted but scarcely less renowned. Anna Morandi was born at Bologna five years later than Lauri Bassi, and died four years earlier. She became the wife of Giovanni Manzolini, a poor, hard-working maker of anatomical models. Manzolini was an expert painter and modeller in wax, and was employed by one Lelli to construct a series of anatomical models for the use of the professors in the Institute of Bologna. Anna not only aided her husband, but soon surpassed him in skill, and particularly in that scientific knowledge upon which the success of their joint labours so largely depended. About this time Giovanni Antonio Galli, a skilful surgeon and professor of Gynecology, opened a school of obstetrics in his house, and, encouraged by him, Anna began to lecture on anatomy to private classes. In these lectures she not only imparted with peculiar talent the knowledge derived from her husband, but she also communicated many discoveries made by herself. So great was her skill in all dissections requiring delicacy of touch and minuteness of detail, and so clearly did she demonstrate, both theoretically and practically, the wonderful structure of the human body, that she rapidly acquired a European reputation, and her lecture-room was frequented by students of all countries.

In 1755 Anna Manzolini became a widow, and was left with very slender means of support, but her good qualities raised up friends who secured for her a comfortable subsistence. Though she received tempting offers from other Italian universities, and even from England and Russia, she preferred to remain in her native city, Bologna. Not long after her husband's death she was appointed to the chair of Anatomy in the Bologna Institute.

Anna Morandi-Manzolini enjoys the distinction of having been the first "to reproduce in wax such minute portions of the human body as the capillary vessels and the nerves." Her collection of anatomical models, still to be seen at the Institute of Science, bears silent testimony to her remarkable skill and accurate knowledge. "Her lectures were delivered in the fragrant cedar hall which is one of the

modern sights of Bologna, and in which Lelli's anatomical wooden figures supporting the canopy over the professorial chair attract general admiration." In the anatomical gallery of the university is to be seen her portrait in wax, modelled by herself at the request of many admiring friends. Anna Manzolini closed a laborious and honoured life in 1774, at the age of 58 years.

The city of Bologna, in the middle of the eighteenth century, saw three gifted women simultaneously occupying seats in the faculty of its ancient university. Besides Laura Bassi and Anna Morandi-Manzolini, of whom we have briefly spoken, Maria Gaetano Agnesi was equally distinguished.

Maria Agnesi was born at Milan, March 16, 1718. At an early age she manifested a remarkable facility for acquiring languages, and when only 20 years old was able to discourse in French, Spanish, German, Greek, and Hebrew, besides her mother-tongue. She displayed marked ability also in philosophy and mathematics, and while still young sustained one hundred and ninety-one theses, which were afterward printed under the title "Propisitiones Philosophicæ." In 1748 Agnesi published a treatise on algebra, including the differential and integral calculus, in which she displayed wonderful judgment and erudition. This work ("Institutizioni Analitichi") was afterward translated by Colson, the Lucasian Professor of Mathematics at Cambridge, and was used by the students of that university. In 1750 her father, who was Professor of Mathematics at the University of Bologna, fell sick, and she obtained permission of the good Pope Benedictus XIV. to occupy her father's chair. In person Agnesi is said to have been beautiful, modest, and of pleasing manners. Her severe studies overtaxed her delicate frame, and shortly after she renounced the world and took refuge among the Blue Nuns at Bologna. In this nunnery she lived several years a devotee and an invalid; she died in 1799.

While Laura Bassi taught physics, Anna Morandi-Manzolini anatomy, and Maria Agnesi mathematics, in the Bolognese University, we might naturally expect the gentler sex to avail themselves of the opportunity of studying under their sisters' instructions. And such, in fact, was the case: the names of some of these students are recorded by the historian, many of whom received the degrees of Doctor of Philosophy and Doctor of Medicine. In 1799 Doctor Maria delle Donne appears as Professor of Medicine and Obstetrics; Clotilda Tambroni was Professor of the Greek

Language and Literature, from 1793 to 1808. To these names should be added those of Novella Calderini, Maddalena Buonsignori, Dorotea Bocchi (who was both doctor and professor) Christina Roccati, Ph.D., Zaffira Ferretti, M.D., Maria Sega, M.D., and numerous graduates of Padua, Pavia, Ferrara, and other Italian universities.

Leaving the Italian peninsula, which was so productive of remarkable personages, we will briefly examine the position of women practitioners of medicine in other parts of Europe.

Beaugrand states that the most ancient document extant relative to the organisation of surgery in France forbids the practice of surgeons and of *female* surgeons who have failed to pass a satisfactory examination before the proper authorities. This paper bears the date 1311. References to female surgeons appear again in an edict of King John in 1352. From these documents it appears that women exercised the function of surgeon under legal authority. At a somewhat later period we find the calling of physician followed by women in Spain, Germany, and England.

In Spain, the Universities of Cordova, Salamanca, and Alcala honoured many women with doctors' degrees. We note also the appearance at Madrid, in 1587, of a learned medical work entitled "Nueva Filosofia de la Naturaleza del Hombre," and published over the name Olivia del Sabuco. Of this person, however, nothing whatever is certainly known, and it has been conjectured that the name Olivia was a pseudonym assumed by some eminent physician.

In Germany many women cultivated medical science: Barbara Weintrauben was an author of no great merit; the Duchess Eleanor of Troppau, Catharina Tissheim, Helena Aldegunde, and Frau Erxleben are deserving passing notice. The last-mentioned was one of the most successful female practitioners of the last century. Her maiden name was Dorothea Leporin, but she is best known as Frau Erxleben. Fräulein Leporin pursued her medical studies at the University of Halle, and obtained a diploma in 1734. She settled in the little town of Quedlinburg, at the foot of the Hartz Mountains, became the wife of the rector of the Church of St. Nicholas in the same place, industriously practised her profession, and became eminent for her skill and learning. Her son, J. C. P. Erxleben, inherited from his mother a love of scientific pursuits, and became a distinguished naturalist and professor in the University of Göttingen.

In England, Anna Wolley and Elizabeth of Kent were

occupied with the preparation of drugs as early as the seventeenth century, and both published works on medical subjects.

In this hasty and superficial sketch of the history of the early practice of medicine by women we would not be true to the facts if we omitted mention of certain ignorant and vulgar women who assumed medical knowledge and medical skill to impose upon a too credulous public. That avaricious women, fond of notoriety and careless of their reputation, should imitate the methods adopted in every age by unprincipled men, is not surprising, though it may be mortifying. To this class belonged Louise Bourgeois, nurse to Marie de Medici, the Queen of Henry IV. of France: though an ignorant charlatan, she acquired extraordinary influence over her royal patroness, and her career abounds in curious eventful episodes. She was the author of several medical treatises on the diseases of women, one of which was published at Paris in 1617.

A century later another female practitioner flourished, of whom women have no reason to be proud. In the year 1738 Mrs. Joanna Stephens proclaimed in London that she had discovered a sovereign remedy for a painful disease. Notwithstanding her gross ignorance and vulgar demeanour she secured a large circle of patients from among the upper and wealthy classes, and, after enriching herself by enormous fees drawn from their credulity, she proposed to make her medical discovery public in consideration of the modest sum of twenty-five thousand dollars. A subscription was started for this purpose and enthusiastically taken up; the clergy, lords, and ladies, with an inexplicable infatuation, hastened to add their names to the list of subscribers. Failing, however, to raise so large a sum of money, Mrs. Stephens's friends obtained a grant of the desired amount from Parliament. The certificate testifying to the "utility, efficacy, and dissolving power of the medicines," bears the date March 5, 1739, and is signed by twenty justices. These dearly purchased remedies were three in number, "a powder, a decoction, and pills." The powder consisted of calcined egg-shells and snails; the decoction was a disgusting mixture of herbs, soap, and honey, boiled in water; and the pills were made of "calcined wild-carrot seeds, burdock seeds, ashen keys, hips, and haws—all burned to a blackness —soap, and honey."

Contemporary with Mrs. Stephens lived another impostor, Mrs. Mapp, sometimes known as "Crazy Sally of Epsom," and described as an "enormously fat, ugly creature,

accustomed to frequent country fairs, about which she loved to reel, screaming, abusive, and in a state of beastly intoxication." This attractive lady was by profession a bone-setter, and was patronised by patients of rank and wealth, who sought her charily bestowed favours with ill-disguised contempt of her person. The town authorities of Epsom greatly esteemed Mrs. Mapp, or perhaps we should say highly valued the benefit the town derived from the influx of wealthy patients, and they offered her the sum of five hundred dollars per annum if she would continue to reside in the town.

The first half of this century has witnessed the career of a few women eminent in the art of healing. In France Madame La Chapelle had an extensive gynecological practice, and Madame Boivin attained to such distinction that she was honoured with the degree of Doctor of Medicine by the University of Marburg. In Germany Charlotte Heidenreich and Frau Heiland, her step-mother, were similarly honoured with doctors' diplomas.

It is the glory of America that she is distinguished above all countries not only as the cradle of liberty, but also as the foster-mother of the intellectual advancement of women. Yet this has not always been the case: in the early chronicles of the colonists (themselves refugees from persecution) we find, strangely enough, many laws of an exacting and repressive character, some of which were aimed directly at the ambition and zeal of women. In the famous Blue Laws of Connecticut the following curious entry occurs under the date of March, 1638:—"Jane Hawkins, the wife of Richard Hawkins, had liberty till the beginning of the third month called May, and the magistrates (if shee did not depart before) to dispose of her; and in the mean time shee is not to meddle in surgery or phisick, drinks, plaisters, or oyles, nor to question matters of religion except with the Elders for satisfaction."—("True Blue Laws of Connecticut," by J. H. Trumbull, 1876.)

A hundred and forty years later we find marked progress in liberality in the State of Connecticut. As early as 1773, in the town of Torrington, Litchfield County, two women were greatly honoured and much sought for on account of their remarkable skill as accoucheuses. The first of these, Mrs. Jacob Johnson, to quote the historian of Torrington (Rev. Samuel Orcutt), was as thoroughly known and trusted in her profession as any physician that was ever in the town. "She rode on horseback, keeping a horse for the special purpose, and travelling night and day, far and near,"

to meet her engagements. "She kept an account of the number of cases she had, and the success of the patients, and the new-comers; and of these last there is at least one living in the town. In the midst of her usefulness she was removed by death, and it became a great inquiry, 'Who will take the place of Granny Johnson?'" This question was answered more successfully than anticipated in the person of Mrs. Huldah Beach, daughter of Aaron Loomis, jun. Mrs. Beach became as celebrated in her calling as Granny Johnson, and continued to attend to her professional duties until an advanced age. She was a woman of remarkably fine personal appearance and decided dignity of carriage, yet marked kindliness of manner. Her intellectual strength and ability was perceptible to every one, and she in consequence commanded great respect in all classes of society, and won the confidence of the people so that but few calls were made on any other physician in her specialty, on the western side of the town. She also rode as far as Winchester, Goshen, and Litchfield.

Dr. Orcutt, whose "History of Torrington" has furnished us with these particulars, remarks in this connection—"Many have imagined that, in the practice of medicine by women, a new era has arrived, but in this there is only a 'restoration of the lost arts.'"

Our allotted task is completed, yet we cannot close this address without a brief survey of the present period, in which the facilities afforded women in all branches of learning contrast strongly with the impediments and obstacles formerly well nigh insurmountable.

Women desirous of acquiring medical knowledge are no longer obliged to disguise themselves in male attire like Agnodice the Athenian, nor are practitioners liable to suffer the penalties of the law for their works of benevolence and charity. In 1880 the young woman with aspirations for intellectual culture finds open to her such excellent training-schools as Holyoke, Wells, and Rutgers,—such noble institutions as Vassar, Smith, and Wellesley. Does she not shrink from contact with her brothers, she may gain entrance into many universities, either expressly founded in a liberal spirit,—as Oberlin, Cornell, and Ann Arbor,—or which have yielded to the steady pressure of public opinion, and now open their doors more or less widely to the gentler sex. To enumerate the latter would be tedious and unprofitable; suffice it to say that even venerable and aristocratic Harvard has lately joined the number, and our own Columbia, should her President's views prevail, will not be slow to follow.

The young woman who seeks intellectual training of a more technical character, with a view to adopting a professional career, will find many avenues opening up with constantly increasing privileges and faciltties. The student in art, thanks to the philanthropy of our venerable citizen, Peter Cooper, can, without incurring expense, acquire a knowledge of designing or of wood-engraving which will hardly fail to secure for her a competence. The student in biology will receive her share of attention at a summer school of science on our Atlantic seaboard, or held in connection with some enterprising institution of learning. The student in pharmacy and chemistry can conduct her researches on an equality with men, or, if she prefer, in laboratories controlled and officered in large part by women themselves.

The student in medicine now gains access to medical colleges in nearly every State in the Union, and the legitimacy of her pursuit as well as her ability to grapple with it gain increasing advocates. "She is no longer regarded as too good and too stupid to study medicine." The candidate for medical honours also finds in Boston, Philadelphia, New York, and Chicago, well-appointed schools of medicine especially adapted to her needs, with corps of trained and sympathising instructors ready to lend a helping hand.

Looking across the Atlantic, we find countries so lately intolerant of the intellectual advancement of woman at last yielding, not always gracefully, to the inevitable. The little republic of Switzerland, and the mighty empire of Russia have for many years manifested practical sympathy with the cause; and now, slowly yet surely, conservative England begins to recognise the fact that the Anglo-Saxon race, with its boasted love of liberty, has been neglectful of its duty to womankind.

To trace any more fully the history of the recent period does not fall within the province of our address; we look to the pioneers of this movement who are still with us, for an exhaustive and authentic record such as participators and eye-witnesses alone can supply.

II. LIFE AND ITS BASIS.

By J. H. Barker, M.A.

Part II.—*Animal Life.*

THERE is a somewhat ambiguous expression of recent origin, and adopted by some writers of high standing in science, viz., "The cosmical life of the Universe." And to this hypothetical source we are invited to trace all life, whether on our own or other worlds. It must be presumed that this 'cosmical life' is some universal principle or power manifesting itself in an unceasing energy and possessed of boundless resources and consummate skill,—if it is the originator of all the fair and wonderful world of life which we see around us, and of which we ourselves, as human beings, form the highest and noblest part. Moreover, this same power or force is regarded by some modern authorities as identical with those mysterious forces which are conspicuous everywhere in the inorganic world, and producing its ceaseless changes and processes. I confess I see no reason to deny or to doubt the reality of such a general force or power.

Professor Haeckel of Jena is a well-known advocate of this theory, and in vol. i. p. 331 of his "History of Creation," he maintains the identity of the inorganic and vital forces, as exhibited in the formation of crystals on the one hand, and living things on the other. But, he adds, with much candour, "The *ultimate causes*, it is true, remain *in both cases*" (the *italics* are his own) "concealed from us." These *ultimate causes*, however, comprise the gist of the whole question. Experimental philosophy may fail to find them, but inductive philosophy clearly discerns and gladly recognises them.

It might appear at first sight the most natural course when treating of the manifestation of life in the animal world, that we should start with the simplest, or as they are generally called, the elementary forms. But as we cannot prove, and in many cases can scarcely infer, any distinction between animal and vegetable organisms of this low kind, it will be better to endeavour to estimate this distinction as it is exhibited in the higher and more complicated organisms.

Let us, then, first notice the indisputable fact, that the

vast majority of the living beings of this order, manifest the possession of *volition* as individuals. This faculty of *will,* if it actually exists, proves the presence of something distinct from, and superior to, matter. And when, in addition to this, an animal shows by its actions that it has the power of *thinking*, of reflecting, of comparing, selecting, calculating (with accuracy within certain limits); and still more when it exhibits natural or acquired sagacity and discernment, observation and imitation; and above all, when it manifests *moral* qualities, even of a high order, such as unswerving fidelity and devoted affection, of gratitude and sympathy, as well as the more ordinary sentiments of fear, jealousy, &c., or of cool, deliberate, and long-cherished revenge for insults or injuries;—what, I ask, are these qualities, so familiar to us all, and especially to students of natural history? They are not qualities of *matter*, nor even of *living* matter, or they would be exhibited by plants and trees as well as animals. The tempers and dispositions of individual animals can seldom be traced with any probability to mere bodily organization, any more than in the human race. In short, innumerable qualities exclusively mental are manifestly possessed by animals, from the 'half-reasoning' elephant down to the ant, which is held up by the Wise Man as a pattern of industry and prudence to the careless and improvident sons of men. It may be pertinent here to remark that, whether we measure the psychical force in the lower animals by the intelligence they manifest, or by the physical strength they can put forth *at will*, no correspondence has been proved to exist between it and the magnitude of their bodily frame, nor yet in the proportion which their nervous system bears to their bodies. They are two incommensurable quantities.

It is true, that as we descend in the artificially constructed scale of animated beings, our means of tracing their mental faculties continually diminish, though this does not disprove their existence. So, likewise. the evidence of the existence of individual volition becomes less and less distinct, and seems at length to vanish altogether; or, perhaps, we should rather say, appears to merge into some other form of force. Nevertheless, volition, as evidenced in voluntary motion, seems to be the best criterion we possess, in the failure of the old tests afforded by organic chemistry, of the difference between a plant and an animal. The distinction is a real one, although we may neither be able to define its lower limit, nor to say at what precise stage in the life-history of each individual, volition commences.

But volition being evident, the next question is, To what

does it properly belong? What is the being which exerts it? As it cannot be matter, which is, *per se*, inert, it must be some active principle. And here we enter upon the domain of psychology. Such a principle has been actually recognised in all ages; it was called by the Hebrews '*nephesh*,' by the Greeks '*psyche*,' by the Latins '*anima*,' and perhaps our English word '*soul*' (though doubtless used also in other senses) comes nearest to it. The Latin word 'anima' is, I think, the most appropriate, on account of its being the root of *animal*, *animate*, and their derivatives, besides its allowing the easier use of the plural noun. I therefore ask my readers' permission to employ it here in preference to 'psyche.'

As to the ultimate nature of this '*anima*,' all we can do is to compare it to our own thinking entity; with respect to which we have most important additional evidence, viz., an intuitive and all but irresistible conviction that it is something of a very different nature from the body, and non-material. Moreover, it is as really a separate being as the body which it animates; and in whatever sense the body has a *unity*, the '*anima*' must also be called *one*. As we descend in the scale of organisms, we meet with an arrangement which appears to indicate a kind of corporate life, which some have likened to a republic of human beings. Is it not possible, however, that in such cases the 'anima' may be single, seeing that in the higher animals the 'anima,' though single, extends through and acts upon a multitude of different, though associated organs?

Let us next enquire into the *duration* of these 'animæ.' In this matter we must invert the order of time, and consider its termination first. Is what we call the death of an animal the end also of the existence of its 'anima?' In the total absence of even a probability of their existence subsequent to the cessation of vital action, and the disintegration of their bodily frames, we are clearly justified in asserting that the 'anima' then ceases to exist; that its existence is more or less a transient one. No reason can be given why such transient entities should not be created, for the *length* of their existence must be simply dependent on the power which calls them into being.

The 'anima,' then, in living animals is an entity endowed with *will*, though human observation may not, in every case, be able to detect its working.

We may now advert to the important but very obscure question of its origin. Is the existence of the non-material 'anima' coeval and coincident with the formation of the

germinal cell,—that mystery of mysteries, as the Duke of Argyll rightly terms it, the nucleated cell on which the future organism is built up? Or, to put it in another form, Is the 'anima' identical with the life of that cell and of those which are added to it in the process of growth? and is it, therefore, virtually an aggregation of such *lives?* The notion appears to be inconsistent with the essential unity of the animal mind, for the living state of those component cells is perpetually ceasing, upon their becoming 'formed matter,' and they are also for ever leaving the body and being replaced by new cells. I therefore contend that the life of the 'anima' is not identical with this cellular vitality in animal organisms. The 'anima' is, of course *connected* with those living cells, and this connection is made dependent to a great extent upon certain conditions, which we call health or disease, of those cells. Yet the 'anima' does not depart when a small portion of blood is shed, although its corpuscles possessed this cellular life. Nor, on the other hand, does the cellular vitality instantly cease with the death of the organism as a whole. As their termination therefore is not absolutely contemporaneous, so neither need their commencement be so: that is, the union of the 'anima' with the embryo may take place at any period of utero-gestation. Whenever it does occur, at that moment it becomes a separate, or rather a distinct, individual.

But *whence* this 'anima'? Is it really to be considered a 'detached portion' of the parental 'anima'? or is it an actual creation? If the noble author above quoted is justified in seeing in the nucleated cell which is the germ of the future animal (see Art. in "Contemporary Review") "the great work of creation," much more may the imparting of that 'anima' which constitutes the living creature itself, be properly so designated.

If we suppose the material organism to be formed from the substance of the parent animal, conveyed to its destined point by the blood, this would not be creation, but formation out of pre-existing matter. But the giving of existence to a new 'anima' may be rightly so termed; and it must therefore be conceded, that this is the direct act of the Creator. This union then, however and whenever made, is the conferring of *life* in the higher sense; it is the making not merely a living atom of protoplasm, but a living being.

But the Creator of the 'soul' is at the same time forming —building up—its habitation; at first within special organs appropriated to that work in the body of the parent animal; and after its birth into the outer world, the process is con-

tinued by direct and ordinary nutrition. In both these stages of its existence, the method of procedure is such as to evolve, *gradatim et seriatim*, an organism closely resembling that of the parent. It is no doubt true, that in this evolution the embryo passes in succession through forms which are observed to be permanent in lower animals; but this only proves the unity of the author and the unity of his plans: there is no chance of random processes. In a few exceptional cases the process is interrupted, and stops short of completion: but our ignorance of the reason for such exceptions is far from justifying a doubt, either of the power or wisdom of the Maker of them. He, having previously bestowed on the parent an 'anima' and volition, may allow that *will* and its results, to affect the process of organization in its body, so as to cause what physiology designates 'abortions,' or 'abortive organs.' And even if it can be shown that such variations are continued for one or more successive generations, this is a very slender ground for the extravagant notion of some naturalists, that each organ has its own *germ*, which is transmitted from generation to generation; or the still more unintelligible idea of involved germs; a theory which sees all its future progeny in a single seed or in a simple molecule of protoplasm.

The number of these 'animæ' must of course be indefinitely great, and their variety hardly less so. For not only do they differ in different species, but in the individuals of each species. The variety is fully as great as that of the bodies they inhabit. But this is a characteristic of the works of Nature; while a grand *unity* runs through all, they are as far as possible from presenting a dull *uniformity*. We may almost say that the Great Ruler of Nature seems to delight in displaying before His rational creatures, the exuberance of infinite resource, in the diversity of His productions.

The hypothesis, however, of the independent origin of individual animal souls, now proposed, seems to contradict the received doctrine of heredity, which regards the '*anima*' as *derived* from that of the parent animal. Let us then consider this point more closely. Little as we know of the essential nature of our own minds (or souls) their individual unity is absolutely certain, as also their non-materiality. They cannot therefore be said to have parts, or to be discerptible. Hence the derivation of one soul from another cannot be taken to mean the detachment of a portion of one soul to form another. Whatever connection then may be predicated between the '*animæ*' of parent and offspring, it can only be

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one *established at the time* by the power which is carrying on the process. But this is the same thing as giving existence to a new being, *i.e., creation.* Further, in the case of ordinary or dual generation, the 'anima' of the offspring would on the above supposition, consist of a union of the 'animæ' of both parents; and this complication would, of course, be multiplied in geometrical progression at every step we take backward among the progenitors. On these grounds, therefore, I cannot accept the common view on this subject; and must fall back on the far simpler theory, that the 'anima' is, as the Scriptures represent it to be, a direct product of creative power. And this applies equally to man and to beast; in short, to the whole animal world. The special similarities of *bodily* form and organic character, although not always regular, may well be supposed to have a *material* connection with those of the parent animals; in fact, this is the law or rule adopted by the Creator; and if he applies the same general rule to the '*anima*' and yet allows corporeal and external influences to modify its character,—this appears to afford an adequate explanation of the principal phenomena of heredity. The difficulties in the path of those who are determined to reduce these obscure phenomena to the domain of *physical law,* are well illustrated by the scheme of M. Haeckel, who invents eight or ten different *laws* of inheritance, some diametrically opposed to others. He seems to make a new *law,* to account for every difficulty. (See History of Creation," vol. i., ch. viii. ix.)

But this, like many other lines of thought, has its highest interest, as well as its highest development, in the human race. Upon the almost boundless subject, however, of human psychology, I cannot pretend or indeed presume to enter, except as to its most elementary principles. The existence of the human soul or living 'anima,' its distinctness from the body, and its non-material nature, however intimate are its present relations with its corporeity, are here assumed. I may go a step further, and maintain—with the writer of the interesting article in the last number of this Journal upon Comparative Psychology,—that the human 'psyche' is of the same *order* of entities as that of the lower animals. In that respect man is an animal too, and his body is animated by a non-material essence similar, however superior in intellectual and moral powers, to theirs. But similarity is not identity of nature: and I am very far from believing that any close bond of union exists between them, than that they are made by the same great Power, and, in that sense have the same origin.

The special subject before us, however, at present, is *life*, as possessed by man. No one can doubt that in all its main features our corporeal life is identical with that of the lower animals, and that it is subject essentially to the same conditions. And as in their case, so in that of the human organism, I conceive it is absolutely necessary to maintain the distinction between the vitality of the *bioplast*, whether connected with the more solid tissues, or floating in the fluids of the body, and the *life* of the *whole organism*. It is to this latter state that we refer when we speak of 'life and death' as regards any individual human being. The necessity of this distinction will be apparent, when we consider the experiments which have been made with such success, in transfusing a part of the living blood of one man into the veins of another, who by disease or loss of blood, was in danger of dying. No one can imagine that the blood corpuscles thus introduced into the failing body of the one person, transported any part of the 'anima' of the other into his body. If we regard, as we must do, the living being, or 'anima,' as one and indiscerptible, the idea of such a transfer, which leaves the person who parts with his blood, in full possession of life and soul, is entirely inadmissible. It follows, therefore, that whatever connexion may exist between the two kinds of life, they cannot properly be called identical. The same inference is to be drawn from the fact before alluded to in regard to animals, that the cessation of vitality in the organs of the body (*e.g.* the contractility of the muscular fibre), is not coincident with the departure of the aggregate life of the system. On the other hand, the corpuscular life may cease, at least partially, in almost any part of the body, while the union of the soul continues intact.

It is as impossible to say what amount of corpuscular vitality is adequate to maintain this union between soul and body, as it is to describe the nature of that union. It may differ, not only in every animal species, but in every individual, and with every period of life. But the fact of some mutual dependence is obvious. The former state is probably of the same nature as that which we see manifested in vegetation, and which predominates in the 'Protista:' the direct acting cause of which is, according to the present theory, the Supreme Will of the Deity.

But the *life* or living state of the whole human body is the union of the 'anima' with the corporeal organism. I suppose this 'anima,' though of the same *order* of being as those of the brutes, yet to constitute a distinct *class*, endowed with far higher prerogatives and capacities, and destined by

its Maker, not for a transient, but for an eternal existence. Into this subject, however, I do not propose further to enter at present. My next step is to enquire whether there appears to exist any material link between body and soul, which is essential to the living state, and which is common to man and other animals.

It is the general belief of physiologists, that in the animal nervous system there exists a fluid, or influence, of a nature closely allied to voltaic electricity, as evidenced by a number of well-known experiments. The human brain is therefore often spoken of as a *living voltaic battery*, and the nerves are compared to the metallic electrodes. It is certain, moreover, that a continuous supply of this nerve influence, is essential both to sensation, and to voluntary, indeed to *all* muscular action. The living being holds converse with external objects, and especially with its fellow creatures, by means of its five senses, at the special seats of which it must be regarded as locally present, to receive and interpret the meaning of the impressions conveyed from outward objects. Now with respect to two of our senses at least, we know that the impression is made by vibratory and undulatory motions in circumambient media, causing corresponding motions in the nerves; those in the æther being transferred to the optic, and those in the air, liquids, and solids, to the auditory nerves. It may be asked then with reference to vision, whether the motion which was unquestionably in the æther suffused through the air in external contact with the cornea of the eye, actually penetrates the clear structures of that organ? According to the corpuscular theory of light, it would be so; but the wave theory only admits the propagation of *motion in æther*. Then the æther must also permeate the ball of the eye, and the ray of light *in* the eye consist of undulations in that interfused æther. May we not then reasonably suppose that this æther meets at the retina with a medium of its own nature permeating and acting upon the expanded nerve-tissue, and taking up its vibrations? The nerve-fluid, however, is not the percipient being, it is but its servant, however indispensable, even as the nervous system and the body as a whole, are. And this seems to indicate such a special connection with the *mind* or *soul*, *i.e.*, the living '*ego*,' that it may be properly termed the *link* between soul and body.

The fact that this æthereal nerve-fluid is also essential to muscular contractility, and so to voluntary motion, offers additional evidence of the truth of this view of the matter. Moreover the necessity for the presence of some degree at

least of heat (another form of æther-motion) to vital functions, and indeed to the continuance of life itself, seems to prove the presence of some form of æther in the nervous system, as well as in every other part of the living body. In applying the term æthereal to the nerve-fluid I do not mean that it is absolutely identical with the free ether of space. But may it not well be, that the æther which undoubtedly exists all around us, may be modified in its qualities by being taken into combination with that wonderful organic product, the nervous tissue? May it not be one of the functions of the brain and of other ganglionic centres to draw from the air, through the aëration of the blood, constant supplies of this vital element?

The blood is no doubt the *life* of the corporeal system, and that in more senses than one. And it is so in a specially important sense, if one of its chief functions is to *distil*, as it were, from the air we breathe, and store up in the brain, that empyreal form of matter, whose activities are requisite to enable the nerves both of sensation and volition to fulfil their varied functions. And in connection with this subject, is it not possible, nay probable, that many of the perplexing but indisputable facts of *Mesmerism* may find a solution, in the action of a strong will upon the nerve-fluid, and by the medium of the æther combined with the air, acting upon the nervous and muscular system of the person subjected to it?

Human 'life' then in the higher sense, is the continued union of soul and body by its æthereal link, and death is the cessation of that union. So far the man and the brute are alike, and perhaps the correlation may be extended one step further, to include the phenomena of *dormant* life; although in some obscure cases it may be wholly impossible to decide whether vitality has finally ceased, until disintegration of the organism has taken place; but here the similarity ends. In the case of all animals except man, the cessation of the life is the end of the existence of their 'anima.' The beasts *perish*—cease to exist. The purposes of their creation have been fulfilled, and they are no more.

Not so, however, in respect to man. To him physical death is that of the body only. As regards *his* 'anima' death is its separation from the gross corporeity which had been in a state of ceaseless flux from the first, and its entrance upon a fresh stage of existence. Into this new condition, it may, and I believe will, enter with the full consciousness of its own existence; and associated with that æthereal substance which in this world constituted the mys-

terious link between it and the body, and will thenceforward be the vehicle of the soul in its new condition. And thus will, we may suppose, be maintained the continuity of material conscious existence. For I regard it in the light of a physical necessity, that a created mind should have some species of embodiment *during its whole existence*. The limitation of mind by material corporeity, seems to be the only possible mode of giving it either individuality or locality. Not that such a state of non-corporeity is an abstract impossibility, but that it seems inconsistent with all we know of the nature and relations of the two entities. The beings we ordinarily speak of as *spirits*, whether they have once dwelt in earthly bodies or not, have probably as real a corporeity as we have, although æthereal in its nature, and therefore ordinarily invisible to us. We must, however, remember that æther itself, the very *matter of light*, is absolutely invisible to us, except it be in a certain definite kind of motion.

I may further observe that it is quite as conceivable that a living being should be embodied in the æthereal as in the more concrete and solid forms of matter. Such a transformation, then, may be in store for the human family, as the late Isaac Taylor shows to be probable on the highest philosophical grounds (see his "Physical Theory of Another Life," *passim*.)

According to our present theory, therefore, matter in some form or other, is the actual *basis* of life, and that probably everywhere in the physical universe. And the only cause and reason of this is, that it seemed good to Him who is the first and last cause of all existences, natural or spiritual.

Of the essence of matter we are, in our present state, profoundly ignorant; we only know some of its effects or properties. But whether it consists of the corpuscles of a Newton, or the fire-mist of a Laplace, the atoms of a Dalton, or the infinite centres of force contended for by a Berkeley or a Boscovich, one thing is certain,—that there is behind and beyond, beneath and above, yea *in* all matter, visible or invisible, known or unknown, a supreme intelligent Being, "the Father of lights," the Maker, Upholder, and Ruler of all, and the ever-living Source of all life.

To sum up briefly the whole subject, I regard terrestrial "life," whether animal or vegetable, not as a distinct *entity*, but *as a temporary condition of certain peculiar kinds of matter*, the efficient cause of which condition is the will of the Supreme, incessantly working as an Omnipresent Being in forming and maintaining living things; chiefly by means of æthereal forms of matter, which are put into various

modes and degrees of motion by the same Power; that some of these activities in the æther are identical with what are known as "the physical and cosmical *forces*" of nature, which as respects their *origin* are not to be distinguished from the vital activities in the molecules of living things:—that this kind of life is simply the continuance of that action in organised matter, and the death of such molecules is the cessation at any point of that action. But in the animal kingdom there is an additional created entity (here designated the 'anima') situated in two terrestrial classes, and united to the corporeal organism as a whole, by a special form of æther in the nerves; that this union while it subsists, constitutes animal life in the usual sense of the term, and that the termination of that union is the death of the whole organism; that the two classes of 'anima' are distinguished from each other by various qualities and capacities, but chiefly by the fact, that the lower class is formed only for a transient existence, which ends with their bodily life, while the human soul is destined for an eternal duration in a future state; and that its natural death is only the separation of the psychical and æthereal parts from the corruptible materials which constituted the soul's embodiment in the first stage of its existence.

I may add, in conclusion, that even if the foregoing theory be discarded and 'life' be regarded as a separate entity, we should still be compelled, with the authors of "The Unseen Universe," to recognise the existence and omnipresence of a great 'Lord and Giver of Life'—the Third Person of the Christian Trinity.

[ERRATA (Part I.).—At page 3, line 10, *for* "only" *read* "chiefly." Page 6, line 14, *for* "speciea' *read* "species." Page 8, line 10, *for* "arcuna" *read* "arcana;" line 30, *for* "had" *read* "to."]

III. THE FORMATIVE POWER IN NATURE.

By Sidney Billing.

WHATEVER be the origin of nature, analogy shows that there necessarily must have been an antecedent to all nature, as we know it, a formative principle. This principle, or all reasoning on that we know and see is ineffective, must be the consequence of a direct purpose, as we find all forms, inorganic and organic, coalesce so as to constitute an homogeneity. When purpose is denied to the formative powers by which nature was builded the result would be confusion, *i.e.*, we should have to fall back upon an accidental agglomeration of substances. Nowhere in nature do we find any warrant for such an assumption, and in nature, as we know it, an impossibility, for a repetition of accidents would never conform in orderly arrangement. Nature works through affinities, producing a continual range of effects proceeding from a primitive cause; it selects the materials fitted for the particular purpose, dispersing those unfitted, to form new combinations. If we find nothing else in nature we find order as an outcome of the perfect adaptation of diversified parts to produce a given result. Whatever the formative principle we see in nature may be, whatever it may be called, God or monism, or any other materialistic name, it is the developing power, or purpose resulting in effects, and necessarily there mu t have existed with it a maintaining power. Whatever thes power or cause it is impossible to ignore a cause,* and whether the cause be deistic, natural, or monistic we arrive at an antecedent something, possessing an intelligence only equalled by its power, by and through which the phenomena of nature arose; and further, whatever this cause, intelligence, or power, it worked out its details by progressive steps.

What is the teaching of geology and palæontology? That each of its vast eras, stretching back in their periods to such immensities that the human mind never really comprehends the interval, not numbered by thousands or millions of years, but by millions of millions, and perhaps even a higher term. Each of these eras presents different stratifications and forms, which stratifications could only have arisen from a solidification of the gaseous substance, which in amalgamation we term the ether. The earth's crust lies in strata, its grandest

* Haeckel, stout an upholder as he is of monism, admits a cause, *vide*, "History of Creation."

divisions are the *primary* or Palæozoic, the *secondary* or Mesozoic, the *tertiary* or Cainozoic, ending with the *post-tertiary* or *Neozoic.* These eras are divided and sub-divided.* No naturalist will deny that the primary stratification differs from the post-tertiary, or to speak more definitely, the Laurentian from the Diluvium. From the Laurentian to the Diluvium there is a regular series of stratifications and deposits, with gradations of formations, lower types by development becoming that which we know as the existing flora and fauna of the earth, and these gradations it is fair to say, progressed as the atmospheric structure, so to speak, was ameliorated. We may call all this mechanical or monistic; the gradation of forms, discerned and descanted on by the Palæontologist, shows that there are no hap-hazards or accidents here; through the successions there is arrangement and order, and this brings us face to face with a formative intelligence and purpose so large in character that the human mind fails steadily to hold up the vision for its contemplation.

When the delicacy, variety, and complexity of animate forms are considered, whether it be the Globigerina with its delicate spines, the Foraminifera with its wondrous mansion, the star fish with its ingenious and peculiar powers of locomotion, the Dinotherium with its huge bulk and seeming unwieldiness, the compact and almost perfect structure of man, the lowly lichen, the towering pine, or sturdy oak, the examiner is in the presence of machines (according to the mechanical and monistic theories) so admirable in construction, so aptly put together, that every part in some way subserves the purpose of the whole, and besides inherently possesses the power of repairing the waste, the result of the vital energy. Can he when all these amazing and intricate contrivances are laid bare before him turn from them and believe that all he has looked on are but the accidents of mechanical adaptations? If when looking at a steam engine, or any other intricate piece of mechanism, we were told that there was no purpose in the arrangement of its parts to produce a given effect, and that the unity of action we saw was produced by an accidental arrangement of its parts, and that the intellect of the constructor had no part in the shaping and placing the cylinders, wheels, and cogs, &c., of the machine, we should think the person so speaking undervalued our intelligence, or was himself incapable of understanding the mechanism before him, however fluent he might be in explaining the functions of their particular parts,

* Lyell's "Geology."

and the admirable adaptability of each to each, contributing without break to the action of the whole. Yet when the processes of nature are the machines in contemplation, in all seriousness we are told that there was no purpose in their construction, no manifestation of intelligence in the adaptation of part to part, no consideration of their fitness, and that there was nothing to show that the object to be achieved was in the contemplation of the architect, who builded so well that, not only were the several parts properly adjusted, but that each object played its part in the machinery of nature; and that those perfect but diversified machines are not only complete in themselves, but are stepstones in the great economy of an orderly universe; and that all this order and manifold arrangement is but the accidental development of particular gases which cohered and produced by their own institution an albuminous substance termed "protoplasm," which in itself had animation and the power of reproduction and differentiation; that there was neither plan nor purpose in the development, that there was neither founder nor architect, but that the accidental agglomeration of different gases intermixing in different proportions would adequately account for the flora and the fauna of the earth.

We may talk of teleology and deride it* and substitute spontaneity, yet when spontaneity is paraded we may well demand from whence was the intelligence and purpose so evidently underlying the processes of nature derived? Human technics require intelligence as an antecedent to mechanical manifestation.† It is then indeed but sorry reasoning to deny intelligence to the formative power through which Nature's machines grew into being. I am not now arguing that this formative principle necessarily is God—that I have proved elsewhere.‡ I am merely testing the sufficiency of the monistic or materialistic propaganda by the commonest phase of surface reasoning. It may be an *a priori* assumption to speak of the existence of God, but language gives no term for that reasoning which denies intelligence to the formative principles dispersed throughout natural phenomena.

All persons who reflect must allow (in fact it is a scientific axiom) that there can be no mechanism or artistic delineation produced without intellectual application, without intelligence as the formative power. A parity of reasoning would lead to the inference that if the technics of man require intelligence to produce and perfect them so would

* *Vide* "Haeckel's "History of Creation," vol. i., p. 66.

† *Vide* Helmholtz.

‡ "Scientific Materialism."

the technics, transcendentally exceeding those of man, as displayed in nature require intellect to conceive and perfect them. The persistence of denial which underlies the whole argument is mainly due to the fact that in Nature's machines we find the completed form without at the same time seeing the process of the details, and so they are pronounced to be self induced; this cannot be said of a complicated machine constructed by human power, or of a fine work of art with the initiation and every manipulation of which we are familiar; yet how easy would it be to understand the diversified mechanics of nature if we did for the processes of nature that which we do when contemplating a machine or a work of art, viz., interfuse the intelligence used in the work, presenting the object as a compound of intellect and material. We would then suppose that when looking at a natural product we were viewing a compound of matter and mind, and that the energy of the formative principle and its power were interfused with the substance out of which phenomena have arisen. Matter then would be considered merely as the vehicle and intelligence as the machinist and moulder of the form; the effect produced would then be but a continuation of the formative cause. Such view would in no way deny the developement theory, the evolution hypothesis as it is called. Scientific theories may be promulgated and sustained without impinging on theological dogmas, with which they have nothing in common, also without a subversion of religious ideas or the reverence which all well balanced minds have for the Great Supreme.

Whenever a systematic denial is given to the theory of evolution we search for the reason and find that it arises either from the absence of a knowledge of its teaching, from an absolute ignorance of natural science, or from a warping of the judgment by some theological bias to which the deniers are attached, and the desire to uphold some dogma in which they are interested. Theologians and materialists equally err, the first in thinking it incumbent on them to uphold at any cost their beliefs, thinking, as many sincerely do, that all discussions of the creation hypothesis and disquisitions on the subject are incompatible with the teachings by which they are indoctrinated; the latter deny the existence of God in creation, deeming his interposition to be teleological or miraculous, as though it were less miraculous to suppose that all we know of nature and of the orbs which stud the skies eventuated without a director or founder: perhaps a great factor in the idea is that the introduction of God into the scheme of the universe would be wholly de-

structive of their supposition. The vehemence of each, in the calmness of reflection, appears equally absurd; that of the theologian in supposing that his creed comprises within itself the all of the creative problem, and of the materialist that in his science he has the ultimate facts of knowledge; yet with the denial he inconsistently admits that there is a *first cause*, at the same time denying to it personality or authority, under the plea that it is indefinable, unknowable and unthinkable. Where is there an ultimate origin which is not so? The scientific axiom that the unknown should be interpreted by the known should at the least teach them that there may be powers in the universe of which they know nothing.

A narrow bigotry—and this is as true of science as of theology—can serve no purpose but that of an acrimonious discussion: it is one-sided, and therefore necessarily it is untruthful. Religious hierarchies are built upon the ignorance of their supporters, and have gained a lengthened existence through a systematic despotism, by which they suppressed all intellectual advances through which alone the tone of the human race could be elevated. The Romish Church throughout its career has manifested a persistent determination to suppress all philosophical theories subversive of the Genesis "revelation." It is to be hoped that the education of the masses will lead to the erosion of dogmatic assumptions, and to a right knowledge of religious and of scientific tenets; it will be then possible to accept Goethe's magnificent idea, and all men will discern God in Nature and thereby be incited to a reverence for the formative power. The propagandists of materialistic dogmas are doing that which the Church has done through the bygone ages, although in an opposite direction; this course can but lead to the subversion of the tenets they would promulgate. The admission of a cause, necessarily the antecedent of all we know or can conceive, appears to be placing the monists upon the horns of a dilemma.

The mechanical theory of the universe may be well upheld (it being the only reasonable Kosmic theory the mind of man can conceive): it is quite consistent at the same time to admit that there is a directing intelligence, and the manifestation of a purpose in the formative processes of nature linked with a power commensurate with phenomenal results and their perpetuation. Herein may be found the keystone of the arch on which an edifice may be raised, the topmost pinnacle of which would be crowned by the entity of God.

IV. EXPERIMENTS WITH THE "JUMPERS" OF MAINE.*

By George M. Beard, M.D.

ABOUT two years ago my attention was directed by my friend Mr. W. A. Croffut to the fact that, in the nothern part of Maine, especially in the region of Moosehead Lake, there were to be found a class of people who presented most incredible nervous phenomena.

These people were cslled in the language of that region "Jumpers" or "Jumping Frenchmen." It was claimed that all, or most of them, were of French descent and of Canadian birth, and that their occupation was mainly that of lumbering in the Maine woods. Mr. Croffut introduced me to D. W. Craig, Esq., a gentleman who had spent much time in that portion of Maine, and who had amused himself with watching and playing with these unfortunates.

In accordance with the request of Mr. Croffut and Mr. Craig, I began at that time an investigation of the subject through all accessible sources, and this year I visited Moosehead Lake in company with my friend Dr. Edward Steese, and made the investigations herein recorded.

I found two of the Jumpers employed about the hotel. With one of them, a young man twenty-seven years of age, I made the following experiments:

1. While sitting in a chair, with a knife in his hand, with which he was about to cut his tobacco, he was struck sharply on the shoulder, and told to "throw it." Almost as quick as the explosion of a pistol, he threw the knife, and it stuck in a beam opposite; at the same time he repeated the order "throw it" with a certain cry as of terror or alarm.

2. A moment after, while filling his pipe with tobacco, he was again slapped on the shoulder and told to "throw it." He threw the tobacco and the pipe on the grass, at least a rod away, with the same cry and the same suddenness and explosiveness of movement.

3. When standing near one of the employés of the house, he was told to "strike," and he struck him violently on the cheek. I took this person into the quiet of my own room, only my friend being with me, in order that the experiments

* Read before the American Neurological Association, June, 1880.

might be made without interruption or disturbance. I sat down by him, explained to him the object of my visit, conversed with him in regard to his family history and his own personal experience and observation of his peculiarity, and every now and then during the conversation, I struck him without warning on the shoulder or on the back, or mildly kicked him; and every time he was so struck he moved his shoulders upward slightly, sometimes moving both the shoulders and the arms, with or without the peculiar cry. He knew that I was studying his case; he knew that the kicks and strokes came from me, and yet he could not avoid making a slight jump or motion, as though startled.

4. While holding a tumbler in his hand, standing near to him, I told him to "throw it." He dashed the tumbler with great violence to the floor, and then began deliberately picking up the pieces in a very quiet and patient way. Whenever I struck him quietly, easily, and in such a way that he could see I was to strike him, he made only a slight jump or movement; but when the strike or kick was unexpected, though very mild in character, he could not restrain the jumping or jerking motion; but the cry did not always appear.

5. A handkerchief was suddenly thrown before his eyes by a person walking stealthily from behind. He jumped, just as though he had been struck.

Another case in the house, a lad sixteen years of age, was not so bad as this other, but still presented all these phenomena: he jumped when he heard any sound from behind that was sharp and unexpected, and struck and threw when ordered to do so. The crowd around the hotel, partly for my benefit, kept him constantly teased and annoyed, so that when he approached he had a stealthy, suspicious, and timid look in his eye, as though he expected each moment to be jumped.

6. This man, while playing with one of his mates, had thrown him to the ground; some one approached near and commanded "Strike him," and he struck him very hard and explosively with both hands at a time.

7. When standing by a window, he was suddenly commanded to "jump" by a person on the other side of the window. He jumped straight up, half a foot off the floor, with a loud cry, repeating the order which had been given to him.

8. When the two Jumpers were close together, they were commanded to "strike": each struck the other simultaneously—not mild or polite, but severe and painful blows. I

took one of these men to my room and quietly conversed with him, and made the same experiments with him as with the other case. I found him much less irritable than the other, and he needed usually stronger excitation to produce the phenomena.

I experimented with him in the phenomenon of repeating language that was addressed to him. When the command was uttered in a quick, loud voice, he repeated the order as he heard it, at the same time that he executed it. When told to strike, he said "Strike" at the same time that he struck; when told to throw it, he said "Throw it" at the same time that he threw whatever was in his hand. It made no difference what language was used. I tried him with the first part of the first line of Homer's "Iliad," and with the first part of Virgil's "Æneid," languages, of course, of which he knew nothing, and he repeated quickly, almost violently, the sound as it was uttered—"Menin Aida," the first part of the first line of the "Iliad," and "Arma-vi," the first part of the first line of Virgil. In order to have it repeated, it was necessary that the command should be very short, as well as quickly and strongly uttered. He would not repeat a whole line, or even half a line, but simply a word or two. In these, as in the mind-reading experiments, I was able to establish my conclusions by exclusion—that is, by proving that only the involuntary action of mind on body could produce the phenomena.

These experiments were repeated again and again, under various conditions at different times, in such a way as to satisfy myself, absolutely, that the six elements of error that apply to all experiments with living human beings were all eliminated, and that the facts obtained were the solid residuum of an exact scientific investigation.*

Many strange things are done by these Jumpers. One of those with whom I experimented came very near cutting his throat the day before I reached the lake. He was shaving, and the door slammed suddenly behind him; he jumped, and had the razor been held in a different way, he might have inflicted a severe wound. One of these Jumpers being surprised by an order to "strike," while standing before a

* The six sources of error in experimenting with living human beings are—1. Unconscious deception on the part of the subject experimented on; 2. Intentional deception on the part of the subject experimented on; 3. Intentional collusion of other parties; 4. Unintentional collusion of other parties; 5. Chances and coincidences; 6. Phenomena of the involuntary life. In experimenting with the Jumpers the nature of the phenomena made it easy to eliminate the main element of error, intentional deception on the part of the subject—since, unless the subject is deceived or at least surprised, the phenomena do not appear.

window, struck his fist right through the glass, cutting it severely. These Jumpers have been known to strike their fists against a red-hot stove; they have been known to jump into the fire, as well as into water; indeed, no painfulness or peril of position has any effect on them; they are as powerless as apoplectics or hysterics, if not more so; the absolute victims of the orders that are given them, or of the surprises that are played upon them; they must do as they are told, though it kill them, or though it kill others. I can find no evidence that the presence of water or of fire will interfere, even in the slightest degree, with the motions which they are compelled to make. As has been made apparent by the above description, it is not necessary that the surprises should come from any human being; it is not necessary that they should be ordered to strike or to jump; any sound from any source that comes upon them with sufficient severity and suddenness, for which they are not forewarned and forearmed, may cause them to jump and to cry. One of those on whom I experimented told me that the falling of a tree in the woods, when unexpected, would have the same effect upon him. He said that one time he was so alarmed by the sudden crash of a tree, that he not only jumped, but was perfectly entranced, so that he could not move, although the tree did not fall upon him. The explosion of a gun or pistol is almost sure to excite these Jumpers. The screech of a steam-whistle is especially obnoxious to them, few of them, so far as I have been able to learn, having been able to withstand it. On one of the lake-steamers in which I returned from the hotel there was a Jumper who, when the screech was heard, jumped right up, so that he nearly hit his head on the upper deck. As the steamer neared the landing and came to a place where he knew the whistle would sound again, he was warned to prepare himself, and he did so with such success that on the first screech he jumped scarcely any; on the second, however, despite his care, he raised his shoulders perceptibly, but did not jump. In many of these cases it may be observed, a simple raising of the shoulders, a sudden impulsive movement, is all that is done, there being no cry and no movement of the hands to throw or to strike. Although called "Jumpers," they only *jump* in a minority of the experiments, the word jumping really including all such phenomena as lifting the shoulders, raising the hands, striking, throwing, crying, and tumbling. Jumpers have been known to fall head over heels over an embankment on which they were sitting, on suddenly hearing the whistle of a locomotive; they have been known to tumble head over

heels over one another, when a number of them were sitting near each other.

The order to "drop it" they are compelled to obey, as well as that to strike, or to jump, or to throw. On one of the steamers on the Rangeley Lakes there was a waiter who was a Jumper, and when told to "drop it" he would drop whatever he had in his hands, even if it were a plate of baked beans, on the head of one of the guests. The Jumpers with whom I experimented exhibited the same phenomena.

These phenomena suggest epilepsy, particularly in their explosive character and in the nature of the cry. The hands strike or throw with a quick impulsive movement, which is very hard to imitate artificially. They go off like a piece of machinery; it is more like the explosion of a gun than the movement of the limbs of even an angry man; and the cry suggests that which we hear in hysteria and in epilepsy. The face does not always exhibit any change, but in some cases there is a temporary flushing, and in others a temporary pallor.

All the Jumpers agree that it tires them to be very much jumped; that they feel worse after it, more or less exhausted and nervous; they all dislike to be jumped, and avoid it when it is possible; the more they are jumped the worse they are; and that after a while in the woods, where they are constantly teased and annoyed after the day's labour is over, they are made worse; whereas, after long periods of rest they become better, are less irritable and jump less, and do not jump so easily on excitement.

Nature of this Disease.—What now is the pathology of this jumping? How are we to rank these phenomena among the neuroses? What relation do they bear to the great family of diseases? Are they functional or structural? Are they physical or psychical? The answer is clear: jumping is a psychical or mental form of nervous disease, and is of a functional character. Its best analogue is psychical or mental hysteria, the so-called "servant-girl hysteria," as known to us in modern days, and as very widely known during the epidemics of the middle ages. Like mental or psychical hysteria, this jumping occurs not in the weak, or the nervous, or the anæmic, but in those, as a rule, in at least good if not firm and unusual health; there are no stronger men in the woods or anywhere than some of these Jumpers. Although some of them are injured by being excessively jumped for the time at least, yet to the majority, if not nearly all, this injury can not be said to be of a serious character. It does not apparantly shorten life, and does not bring on, so far as I can learn, any other form of nervous disease. It can not, therefore, be said to be in any sense a

disease of nervous debility. Those who suffer most from it are the very opposite of neurasthenics or anæmics; they have none of the symptoms detailed in my work on nervous exhaustion; they are full-blooded and strong-nerved, capable of working hard and long at the most toilsome service, and will hold themselves up full and sturdy and enduring, side by side with the hardiest men in the nation. Like "servant-girl hysteria," and like certain forms of chorea or "jerks" as they are called, which appear or have appeared in certain religious revivals, like the "Holy Rollers"* as they were called in the religious revivals of northern New Hampshire, these Jumpers are contributions to psychology more than to pathology. Far out of the range of the aided senses, far beyond the reach of the microscope, or perhaps of the spectroscope, there may be molecular changes or disturbances which manifest themselves in these jumpings and strikings and throwings as a result and correlative. But for the present, possibly for all time, we can only study this subject psychologically; we can only approach it satisfactorily from the psychological side. Only those who clearly recognise the two distinct types of hysteria, the neurasthenic or anæmic form, which may be called *physical* hysteria, and the mental or psychical form, which may be called *psychical* hysteria, can understand the nature of this peculiar malady of the Jumpers; but those who do comprehend and recognise these two types of hysteria will have little difficulty in comprehending the general nature of this jumping and its position among the neuroses. Some of the cases of hysteria major on which Charcot has experimented with his metals and magnets belong, as I am persuaded from personal observation, to psychical or mental rather than to physical diseases. I can find in the families of those who suffer from jumping no proof of any form of functional or organic nervous disease.

Jumping is, therefore, a *trancoidal* condition, exhibiting a part of the phenomena of trance, and bearing the same relation to trance that certain epileptoidal conditions bear to epilepsy.

Although the phenomena exhibited by the Jumpers are analogous to those of mesmeric trance, of mental hysteria, of the "Jerkers" and "Holy Rollers" in revivals, they yet differ from all these and all allied forms of nervous disorder in these two respects:

1. The *momentary* character of the manifestations.

In but a second or so all the acts of the Jumper—striking, throwing, dropping, crying, jerking, or jumping—are over

* So called because they rolled over and over on the floor while under religious excitement.

completely, and he is about in the same condition as before he was surprised. The explosion of the Jumper, like the explosion of a revolver, is sudden and instantaneous; and like a revolver, also, the Jumper is at once ready for a new explosion on proper excitation. If we look at a Jumper five seconds after he has been jumped, we see no sign or indication of what he has just done, or of what he can instantly be made to do.

On the other hand, the phenomena of trance, of mental hysteria, of the "Jerkers" or "Holy Rollers" may last in any given case from several minutes to several hours or days.*

Recent German investigations have, by an interesting coincidence, demonstrated that subjects in the mesmeric trance sometimes exhibit the phenomenon of repeating automatically what is said to them. Berger produces this effect by laying his warm hand on the neck of the mesmerised subject.

2. In the persistence and permanence of the liability to be excited.

After once the habit of Jumping is formed, the subject, though varying in susceptibility at different times, is yet always capable of displaying the phenomena in a greater or less degree at any moment; once a Jumper always a Jumper expresses the prognosis. Epidemics of jerking and rolling are, on the contrary, limited in time and in their sphere, disappearing and dying utterly away with the excitements that give rise to them, and the habit of hysteria or of being entranced may also be outgrown.

Psychologically, these Jumpers, so far as I have been able to see or to learn, are modest, quiet, retiring, deficient in power of self-possession, conceit, and push, but no more so than many others in various races. I have been told that they were of a low order of organization—half-breeds, partly French, partly English; but in this respect I was misinformed; they are at least as intelligent and as capable of fulfilling the duties belonging to them as the average of their associates who are not Jumpers; some of them can read and write, and all whom I saw could converse in English with a reasonable degree of intelligence; possibly as much as we could expect of persons of their age and environment. But all of them, without exception, were of shrinking temperaments. In the chorea epidemics of the middle ages, or of the great religious revivals of this country, this class would be very likely to have been attacked.

* In my work on "Trance" these phenomena are described in more detail than is here possible.

V. A DEFENCE OF THE DOG.

By H. Bellyse Baildon.

THE dog has had his day! The most versatile, intelligent, and faithful of animals, the comrade and ally of man from savagery to civilisation, has received sentence; he is like the Caucasian, "played out;" an *invisible* hand has written on the kennel, that his days are numbered, that he has been weighed in the balance and found wanting. He is not, indeed—desirable as that appears to be—to be exterminated by sweeping slaughter, to be proscribed at once for immediate execution. No; but the "schoolmaster is abroad," and slowly, but surely, man is to be educated into a contempt for his *quondam* companion until he reaches the point (the very *nadir*, alas! of meanness) of giving his old friend the cut direct. On the altar of economy, science and civilisation, the victim is to be bound, and the sacrificing priest is to be none other than his old crony and accomplice. What a pathetic parting will it be between the last dog and the last master; what infinite reproach in the silent, wistful back-look of the contemned servant; what dumb, unspeakable shame in the heart of the regretful lord! Then as the years go by, the memory of the extinct monsters will grow faint; no record remaining of them, save their ghastly effigies on the dusty shelves of museums; for we will surely be too much civilised to care to preserve such relics of a bygone superstition as the now-admired pictures of Landseer. Our posterity will wonderingly refer to their zoological text-books to discern what quadruped mammal it could be which recognised the returning Ulysses and died at his feet. And the Dryasdusts of the period will contend as to the true form of the skeleton of the member of the vertebrate kingdom who licked the sores of Lazarus.

It is well that there are philosophical minds that can contemplate such a consummation with equanimity, not to say satisfaction. The present writer must confess that he has not yet attained the necessary intellectual altitude to enable him to regard the final separation of man and his immemorial associate in good and evil without a pang. Historically, pre-historically, and scientifically, to say nothing of socially, economically, ethically, and psychologically, the dog presents a subject of almost unique interest.

His attachment to man's service marks an era of supreme importance to the anthropologist. Cuvier goes so far as to say "the dog is the most complete, the most singular, and the most useful conquest ever made by man," and, while it is very difficult to compare it exactly with so noble a rival as the horse, one is certainly bound to admit that it performs a greater variety of services to, and is almost invariably more of an intimate with man. In this reference how completely the strong points of the dog supplement the weak of the primitive or savage man! As to the senses, the sight, taste, touch, and even hearing of man might have been fully on a par with those of his coadjutor, but his scent must always have been (regarding him as a frugivorous quadruman) vastly inferior; the dog having probably the most discriminating, if not the actually keenest, olfactory sense of any living creature. Nor is it likely that biped man ever possessed the splendid turn of speed which dogs of the hound kind can command; still less has he the formidable prehensile apparatus furnished by a dog's teeth and jaws. Thus, man could hardly have been a hunter before his fortunate alliance with the dog—at least his success must have been very indifferent. Besides, he would be so much more liable to destruction himself by the more formidable beasts of prey, of whose approach his defective organs of smell would not timeously apprise him. Of the beginning of this most effective defensive and offensive alliance we have no record, as we have conclusive signs of its existence far back in prehistoric time, a fact which of itself should be sufficient to render the animal an object of permanent interest, if not of respect and regard, with the man of science. We constantly hear protests from naturalists against the destruction of rare animals, whether birds or beasts, even when they are wholly predatory; much more must we protest against the bare idea of the extermination of the dog. At least let us preserve him until he has been exhausted as a subject of study. Now, as it happens that investigators like Herbert Spencer and Dr. Bastian have only initiated that study on the basis of combined physiologic and psychologic facts, it follows that upon that score alone the friend of man ought to have a long lease of existence. Anyone wishing to be made aware how pregnant and interesting this subject is, should read the admirable summary of it by Mr. Grant Allen in the *Gentleman's Magazine* for September, wherein he fits together existing knowledge of the matter, supplementing it with his own careful and acute observations. And, perhaps, here I may be allowed, without launching upon the infinite sea

of dog anecdote, to mention some matters which have puzzled me with regard to dog knowledge which Mr. Allan's paper does not touch upon or leaves unexplained, in the hope that he or some other cynologist may enlighten us.

The most important and largest problem which it seems awaits solution is expressed in the question "How do animals, and notably dogs, cats, and horses, communicate ideas, as they unquestionably do, to one another without speech?" I have noticed, as everyone acquainted with dogs must often have done, one dog run up to another (a familiar friend, of course), and, simply by laying his nose to his crony's, put him in possession of some fact, idea, or intention. One could, at any rate, draw no other inference from their conduct, seeing that they immediately started off together in a most purposeful style, as though resolved and unanimous. It was just as though one said to the other, for example, "The gardener's cat is sitting on the window-sill of the toolhouse; suppose we go and hunt her?" To which, to judge by the alacrity of his consent, the other seems to reply, "All right, old fellow, with the greatest pleasure in life." Perhaps it may be suggested that, after all, this is to make the dialogue unnecessarily elaborate, whereas the application of the nose may only have been equivalent to a nudge or a wink, meaning, "Come here, old fellow, there's some fun going." But I think that, apart from the deliberative air the second dog assumes on receiving the communication, the other could quite well by a signal bark have summoned the other to him. No doubt in this particular instance the bark would have spoilt the sport, but there must be many others where this objection would not apply. Mr. Allan's view of the "Dog's Universe" certainly suggests an answer, although that answer may seem one not easily credible. I would state the matter in this way: If the outer world expresses itself to the dog's mind mainly in terms of smell (as ours does mainly in terms of sight), and if, as seems very possible, his mind correlates these sensations so far that his smell-world becomes a whole and not a mere series of separate impressions (even as our sight-world does to us), does it not seem likely that, even as we can express so much directly by the eye, although by no means shut up to this instrument of expression by reason of our gift of language, so the dog may have some faculty of expressing himself through the nose. This would, no doubt, involve the faculty of emitting a certain odour at will, so as to form a code of smell signals. And the incredibility of this idea is considerably lessened when we recall the fact

that many animals have the faculty of evolving certain very perceptible odours when excited or irritated. All that would be required would be an extension of this faculty so far as to allow of a sufficient variety of odours being given off to constitute the elements of a code. That the dog is able to convey his emotions in some such way appears certain from the conduct of dogs when they meet. Except in cases where there is an old-established feud or friendship they invariably go through certain preliminary observations of canine etiquette, and not until these are punctiliously performed do they proceed to demonstrations of friendship, or overt acts of hostility. Somehow, they seem empowered to carry an insult or a welcome, to express enmity or amity. Whether a dog forms his opinion of another by his smell, as we judge a person "by their looks," one cannot decide, but certainly the nose and not the eye seems to be the critical organ.

I agree with the writer of "A Dog's Universe" that it is unphilosophical to account for his power of taking a straight route to a place from which he was brought by an indirect one, by ascribing to him a special "sense of direction." Then this animal seems to have the power (which we do not possess, except to an extremely limited extent) of discovering the exact direction from which an odour is coming. Human beings, of course, discern direction infinitely better by sight than by any other sense. We may be able to tell the direction from which an odour comes if the source is a few feet off, that of a sound although a good many yards off. But as to both direction and distance we are best informed by sight. Dogs do not seem to see things at a distance very clearly, and often appear at a loss as to the exact *locus* of a sound, although its origin is no great way from them. It follows from these facts that they must get their notions of direction from odours. A trail, I suspect, is as distinct to a dog's nose as the track of a steamboat or footsteps on snow are to our eyes. Hence I would explain the case of the hound which, according to Dr. Bastian, "was sent from a place in County Dublin to another in County Meath, and thence, long afterwards, conveyed to Dublin Town," and which from thence found his way in a direct line to his native kennel, by saying, that some day, when the wind was blowing from that quarter, a whiff of the scents familiar to his puppyhood was carried to him, and he was seized with home-sickness, and forthwith set off in the right direction. Whether he travelled by road or across country I do not know. If he went by road he might be assisted by the trail

of some inhabitants from his native village, or from someone who had recently passed along it. Or, again, it may have been the presence in Dublin of someone familiar to him in youth that gave him the clue to the direction of his home—in the first place by arousing old associations, and secondly by affording him a trail to follow up or trace back.

Perhaps we have followed this scent rather far, but before making a fresh cast I would like to tell one dog story, in the hope that Mr. Allan or some other authority may give the *rationale* of it. I may say that I have the story at first hand, and that I know the dog it is told of *personally*, and know other instances of his sagacity little less remarkable. His master had received two invitations for the same evening, one to dinner, the other to a dance or card party later on. Neither of the houses were those of intimate friends, and if the dog had been at either, it was only a very few times. When the master set out for the dinner, he told Gyp that he could not come with him, and the dog, with an air of profound depression and reluctant submission saw him depart without an attempt to follow. Sure enough, at the first place of call no Gyp appeared, but when my friend presented himself at the second he was greeted with the exclamation, 'Why, Mr. ——, your dog has been here ever so long, waiting for you." Gyp greeted his master with slightly embarrassed but effusive welcome, as much as to say his obedience was literal, and not to the spirit "Oh, I'm so glad to see you, and you know you didn't say I wasn't to come *here*." The mere chapter of accidents will hardly account for such a coincidence as the animal going to the right house and waiting there some time. Had he merely called there and happened to hit the time of his master's coming, one might have said he was going a round in search of him, and had made a fortunate guess. I will not here attempt to explain the matter, rather trusting some expert may be able to elucidate it.

So much, then, for a single aspect of cynology—or, rather, so little; for it is a subject that would make material for volumes. What one may call dog-lore, including in the term legends, tales, superstitions, nursery-rhymes, incidents, fables, proverbs, up to actual historical events, would form an extensive literature, and has not received one whit too great attention, being well worthy of more systematic treatment than seems yet to have been given to it. It is obviously impossible within the limits of a reasonable article even to outline this vast field, but the mere indication of it should be sufficient to make us pause before we conclude the dog has become, or is fast becoming, a worse than useless

luxury, which it is desirable to be rid of as early as possible. But to this conclusion the author of the article on "Modern Cynolatry" seems to have arrived, and upon what are, to my mind, quite insufficient grounds.

In the first place, your contributor assumes the comparative uselessness of the large majority of the canine species, an assumption which cannot be allowed to go unchallenged. Wishing to keep the argument down to convenient limits, we will not, as he has done, go beyond the British Isles to find our instances of combined usefulness. To take one very clear case, the utility of the sheep-dog or herd-dog is unquestioned, and although it is on unenclosed land that they are less dispensable, they are in constant and exclusive use in the driving of sheep, cattle, and other animals from place to place, in singling out individuals from a flock or herd, and so forth. Imagine such ordinary operations as sheep washing, clipping, or marking, carried on without dogs! At the same time, I doubt not that a large percentage of the biting laid to the charge of dogs may safely be attributed to collies and dogs of that strain, seeing that they are (with strangers) about the most uncertain and crossgrained of their race. Would it not be very hard that a farmer or shepherd should lose a cherished and valuable dog, because in a moment of mistaken zeal, it had once bitten a human being? Personally, if I were the victim, I should not think of exacting the penalty, firstly, because it would be greatly disproportionate to the owner's blame; and secondly, because the continued life and health of the dog would be the best guarantee of my own safety, or the clearest and most important index of the reverse. In this reference it is, perhaps, only fair to admit that I have never, though having to do with a good many dogs, been bitten in anger by a dog, though I have frequently had the blood drawn in accidentally playing with one. Several times I have been attacked ferociously, but invariably found the use of a stick or umbrella, or, indeed that of the voice sufficient to keep the brute off. One cannot help suspecting that Frank Fernseed has not been so fortunate in his experience of the kind and has at some time been bitten, with resulting cynophobia. As there are some men who never sit a horse well, however much they ride, so there are some persons who never get on well with dogs, while there are others, like Sir Walter Scott, who seem to have an extraordinary fascination for them and for all animals. Undoubtedly the one thing a dog respects is courage, as is well illustrated by the story of Emily Brontë and the bulldog. The one fatal thing in an

encounter with a dog is to show the least atom of white feather; yet to any person of highly nervous temperament, or one unaccustomed to command animals, it is doubtless very difficult to sustain an attack wtthout flinching. The instinct of predatory animals is that of pursuit, as seen in their young, which pounce on or follow up any object, animate or inanimate, which retreats from them. Cats and dogs will often appear indifferent to the presence of a rat in a confined space, though keen and clever enough at seizing them when running off in the open. It is this instinct of pursuit that makes it so natural for a dog to run after a stick or stone, so that the only parts of the fetch-and-carry trick that needs much education is the returning to the master and relinquishing the missile. Hence it is that the least retrograde movement in the presence of a canine enemy is so dangerous. And in view of these facts and considerations, I cannot but think that the great majority of those who get seriously bitten, owe it, in part at least, to their ignorance of dog-nature. The observance of a few rules will save most adults, under ordinary circumstances, from being bitten; such as: "Stand your ground resolutely and speak boldly to the dog;" "Do not pat a strange dog till you have held out your hand to him and seen that he receives it in a friendly manner, and then, if he does not lick it or wag his tail, leave him alone;" above all, "Never touch any dog *while sleeping*, as they undoubtedly dream of hunt and combat, and the touch, however friendly and gentle, may take the shape of an attack or menace from their visionary antagonist, and thus induce them to snap in its direction before fully awake." Now, even as we must learn by experience the physical properties of surrounding objects, it surely is not too much to expect, even from the "average man," some knowledge of dog-nature. I quite fail to see why a man who, through his ignorance of dog-nature gets bitten, has any more claim upon our sympathy than the man who, through ignorance of gas-nature, gets burnt or blown to pieces. We pity both, doubtless, but while we say, "What a fool to go near an escape with a candle!" why should we not say, "What a fool to touch a sleeping dog!" The greatest difficulty is with children, who almost invariably display towards animals a perilous intrepidity or a still more perilous timidity. Yet there are dogs who will suffer themselves to be pulled about by children with an amount of patient endurance not excelled by that of the best-natured bachelor uncle.

But we must return to the question of canine utility, which apart from that of those in which it is universally and legally

acknowledged, we still maintain to be very great. Take, for instance, a class of dogs which one might at first sight be tempted to rank as useless, viz., little pet dogs. Yet it is stating the case very moderately to say that these dogs in the aggregate constitute as great a protection to householders and their property as do the whole of the police force. They are the one guardian element (when kept *inside* of course) which the burglars cannot overcome or tamper with. Personally, if I had to choose betwixt having a policeman within half a mile (I am referring to the country) and a dog within my house, I should not hesitate a moment to elect to take the dog, which both as a deterrent and a preventive I should expect to prove the more effectual. Seldom or never do the police prevent or detect in progress a burglary which has been determined upon by the professors of that art, whereas the first yelp of a pettish terrier sounds the knell of the robber's hope. Moreover, the value of such dogs in this respect arises from their highly excitable and even irritable natures, and one that is uniformly friendly and good-natured is all but useless. Hence, undoubtedly, this class is responsible for a great deal of the biting that takes place, yet it would seem manifestly unjust to visit a single offence of this kind capitally on a dog as it would be to shoot a horse for throwing his rider, or running off with a carriage in a crowded thoroughfare.

Even with regard to the large watch-dogs, although the professional burglar can doubtless deal with them only too efficiently, still, while they are always an additional obstacle even to him, they are certainly a great protection to gardens and orchards from the inroads of petty thieves. They likewise constitute the most effective guardians a lady walking out alone or a man going through dangerous neighbourhoods at night can obtain. I never heard of a man being garotted when he had a large dog with him. So that even this kind of dog is not so completely played out as your contributor would have it appear.

There still remain to be considered those dogs that assist man in his predatory pursuits, but which are more politely termed sports. Their name is legion, and they range from the tall, wiry deerhound (with something of the grace of its quarry) to the shivering rat-pit terrier and debased-looking bulldog. The question of the ethics of the higher forms of field sports is too complex to be discussed here, and would have to be answered before any decision as to the utility of this class could be arrived at. Still, it would be difficult to prove on broad grounds that fox hunting, grouse shooting,

or even coursing, are necessarily degrading employments; nevertheless, rather than seem to press a doubtful advantage, we prefer to admit the absence of strict and immediate utility in this division. And most cordially and unconditionally is it here confessed that the society of the prizefighting bull-dog and the cat-worrying and rat-pit terriers does not tend to elevate their masters. Likewise must Mr. Fernseed's opinion of the validity of the "poor man" argument be here thoroughly endorsed. The poor have so little to lose that they do not require dogs as guardians of property. Nor is seven-and-sixpence a sum which would deter any skilled labourer from keeping a dog if so inclined.

As to the treatment of stray, ownerless dogs I consent, however sorrowfully, to your contributor's sentence of "judicious butchery," and I do so from the dog's point of view no less than from man's, seeing these neglected curs—the chief, if not the only source of rabies—are lucky in being put speedily out of existence. Further, I fail to see the great hardship of enforcing, especially during the summer months, the wearing of muzzles, which, made of wire and properly fitted, are but a very slight infringement of the creature's comfort and liberty. Particularly is this desirable where dogs are allowed, as many are, to wander about alone, uncontrolled by their master's presence. There are likewise certain canine crimes and misdemeanours that demand severe punishment. Sheep-worrying I would make a capital offence, as it is an all but incurable habit, corresponding to dipsomania in the human race; it should certainly be competent to the guardian or the owner of the sheep to shoot the dog if caught in the act, or for the magistrate, if the offence is brought home, to order the brute's destruction. The practice some curs have of rushing at and following horses and vehicles is decidedly dangerous as well as annoying, yet, not being by any means absolutely incurable, the first few instances might be left to the master's discipline; but in confirmed cases, when he will not shut up the offender, he should at the least suffer heavy fining. A few sharp punishments should cure a young dog with any docility in his nature of this pernicious habit, and as a general principle an owner should be liable for any damage resulting from his dog's misconduct; that is to say, when it is not occasioned by wanton provocation on the part of the sufferer.

But, after all is said, the existing law is not so inefficient as Frank Fernseed wishes to imply, which anyone may see by glancing over any summary of the law on the subject; and, indeed, it would be difficult to increase its stringency

without occasioning hardship to dog owners and to the animals themselves. That we cannot shoot a dog offhand, like a wolf, is a very irrelevant complaint. It is simply a case of the general principle that in a law-governed country one must not, except in the extremest danger, take the law into one's own hands; for even a burglar cannot safely be shot unless it can be shown that he is threatening your person as well as your property. That so many as 14,000 people should suffer from dog-bites and 35 perish by hydrophobia annually is deplorable, doubtless, but it cannot be accurately described as a "wholly gratuitous curse." That a certain moiety of these injuries and deaths might be prevented by greater care on the part of dog owners and a more rigid administration of the existing law, there is no room to doubt, yet it would be difficult to find any other cause of death to which we are liable which counts so few victims as 35 per annum. No facts, indeed, are more liable, with all their apparent certainty, to give a seeming basis to unsound deductions than statistical ones. What an appalling chapter could be written on the destruction of life through horses? All populous towns, and London especially, appear positive shambles when we read of the daily, far less the annual, destruction by horse traffic. Yet a horse is, in numberless cases, quite as much a luxury as a dog. The carriages of the wealthy are only in the remote and secondary sense necessities, and even travelling by cab or omnibus is frequently a lazy luxury. By cutting off, through removing all unnecessary vehicles, this "wholly gratuitous cause," more lives would be saved in a week than would be saved in a year though every dog in the kingdom were hung to-morrow. As to cost, there is no comparison, and if one were but paid the annual expenditure over horses one could safely undertake to endow the whole canine community with a sufficient and perpetual annuity.

But, even for a moment granting the supposition that the utile functions now performed by the dog may be in the future executed by some other agency, we should still expect to see the dog flourish almost as before. A pet dog is to many people a great pleasure and entertainment, in short, an immense *luxury*. As to which thing, luxury, there is a point to be cleared up. A luxury is often spoken of as synonymous with a superfluity, and, therefore, the contrary of a necessary. This is not so, for it is a curious point in human nature that with it *some luxury seems a necessity*. Smoking and drinking are undoubted luxuries, and yet they are the last thing that the poorest will dispense with. In

fact, the harder a man's life is in the main, the more determined he seems to have some hours of luxury at the end of his day of toil. Hence some of the most skilful and industrious of mechanics are most liable to indulge in their staple luxury of drink. To say that a thing is a luxury is not the equivalent to saying that it can practically be easily dispensed with. And one is undoubtedly well within the mark in saying that a pet dog is one of the cheapest, safest, and most innocent of luxuries.

VI. A SAFETY PAPER FOR CHEQUES.

WE have to notice an unobtrusive but yet important invention, destined, unless we are greatly mistaken, to put a final stop to one of the most ingenious and formidable frauds of the present day. As the commercial world is but too well aware, a man who is supposed to be financially sound, sometimes makes the disagreeable discovery that a cheque bearing his signature has been presented and paid at his bankers, the sum being much larger than that shown by the counterfoil. The banker has committed no error or oversight in the matter, the drawer's signature is indisputably authentic, but the figures and words expressing the sum have evidently been altered. For this purpose the writing must have been wholly or partly effaced and other figures or words carefully substituted. This process, difficult as it may appear, presents nothing impracticable to a man conversant with the nature of colouring matters. The inks in common use, numerous as they are, and various as is their composition, are all capable of being discharged by chemical agents, some of them of an acid, and some of an alkaline nature. The knowledge of how this operation may be effected is not confined to upright men. A rogue may study and experiment for this end as carefully and patiently as a colour-mixer might in attempting to bring out a new discharge style in calico printing. Further, though we do not believe that any chemist of recognised eminence would knowingly give advice to any intending forger, yet it would be easy to

put the question in such a manner that the applicant's purpose would never be suspected. When once the writing in the body of the cheque has been effaced, the paper is re-sized and such a sum filled in as amply repays the operator for his trouble.

It must not be supposed that bankers have made no attempts to defend themselves against this fraud. Colouring matters calculated to be affected by any agent supposed capable of discharging writing inks have been mixed with the paper pulp, and applied in various designs to the face and the reverse of the documents. Before us lies a cheque which has been filled up experimentally for the purpose of testing those supposed safeguards. The paper itself contains Prussian blue, produced by successively treating the pulp with potassium ferrocyanide and with a per-salt of iron. This tinting is intended to detect the application of any alkali which would decompose the Prussian blue and produce in the place of a blue tint a rusty yellow. On the reverse side of the cheque is a design in ultramarine, a pigment easily destroyed by acids, while on the face the name of the bank and the space to receive the writing are executed in an aniline violet. It may perhaps surprise the non-chemical public to be told that these precautions can be overcome. Such, however, is the case. The words "eighty-seven pounds," and the figures, "£87 0 0," for which sum the cheque was filled up, have been completely effaced, leaving the name of the payee and the word "Specimen," written where the signature would stand, untouched. Not only so, but the general tone of the paper, the ultramarine design, and the violet tinting on the face are unaltered. A gentleman of great experience in the tinctorial arts, and accustomed to detect the slightest difference in colours, declares on comparing the effaced cheque with one in its original condition that he could not detect any alteration.

The invention which we are endeavouring to expound, and which is due to the ingenuity of Mr. A. A. Nesbit, F.C.S., takes a point of departure at once novel, and yet as simple as the egg of Columbus. Every chemist knows that there are colours, of which litmus may be taken as a type, which are capable of being modified both by acids and by alkalis, but in a different manner. Suppose the cheque is first coloured a pale uniform greyish blue with neutral litmus. If we then print upon this with a dilute acid we shall produce red letters, lines, or devices. By a second application, of an alkaline liquid, we produce decided blue lines or devices, which may be interwoven with the former. We then fill

up our cheque with any ordinary writing ink, and pay it away in perfect confidence. Let us suppose it falls into bad hands. To discharge the writing he applies, say, a dilute acid or the solution of an acid salt. Immediately the whole surface of the cheque assumes one uniform red colour and the letters, lines, and other devices disappear. Suppose he then tries to undo the mischief by the application of an alkali or the solution of an alkaline salt. At once the whole document is turned blue, and the words, &c., are not reproduced. If he applies the alkaline liquid first, the design is equally destroyed. Let us even suppose that the forger discovered some perfectly neutral liquid capable of removing writing ink. Even here he could be met by the simple contrivance of printing the design in a deeper or a paler red, produced by the application of a stronger or a weaker acid. If a design thus produced is moistened even with a neutral liquid, its distinctive shades will be affected and the characters blurred. The invention further proposes to print inscriptions and marks on cheques partly by the method already described, and partly in ordinary printers' ink, "the inks being so printed that the marks or inscriptions are composed of fine lines or lettering of the dye alternating with lines or lettering of printers' ink, the printing being effected in a machine of very delicate registration." Hence, if all the coloured part of the inscription is removed from a cheque, it is practically impossible to reprint it, even with the block with which such coloured part was originally produced.

The acid which the inventor prefers is the oxalic, as it possesses the property of not corroding the plates or blocks used in printing. It forms upon the face of the plate a thin layer of insoluble oxalate, and thus prevents all further action. In the important point of cheapness, nothing can be objected to in Mr. Nesbit's process.

Judging from our present knowledge the invention may be pronounced an easy, simple, and effectual means of overcoming a growing evil.

ANALYSES OF BOOKS.

*Philosophische Consequenzen der Lamarck-Darwin'schen Entwickelungs theorie.** Ein Versuch von Dr. Georg von Gizycki. Leipzig and Heidelberg: C. F. Winter.

In all countries, and certainly not less in England than elsewhere, the first question put regarding any new theory is not so much "Is it true?" but rather "To what does it lead?" The public is uneasy lest even the most abstract scientific generalisation may throw an unfavourable side-light upon some of its recognised orthodoxies, and will not be consoled with the truism that the novelty, if rightly induced from established facts, cannot be hostile save to errors. Unusually violent and lasting has been the excitement in the case of the doctrine of Organic Evolution. Men of culture, and even of special scientific training, like Prof. Virchow, have seen in it not a theory to be dealt with like the undulatory hypothesis of light, or the conservation of energy, or the Mendelejeffian law of elementary periodicity, but as a "heresy" "leading"† to social democracy, Nihilism, Agnosticism, and other fearful manifestations of the *spectre rouge*, and worthy not of discussion but of repression, as hinted in the too famous watchword "Restringamur." Nor must it be forgotten that certain men, champions of the social and theological views dreaded by the "powers that be" have somewhat prematurely claimed Evolutionism as an ally. Some of these coincident hopes and fears have been ably dealt with by Prof. Oscar Schmidt. Still ample room is left for our author, who enters upon his task with the declaration that "a more profound philosophy must protest against such an abuse of our great theory *in majorem materialismi et atheismi gloriam.*" His object is to trace out the consequences of the Lamarck-Darwinian theory of Evolution in four main directions—as regards psychology, the theory of cognition, morals, and religion. It may here be remarked that many foreign authors do not sufficiently distinguish between Evolutionism in its widest sense, the general theory that animals and plants as we now find them have arisen by the transformation of a few—possibly of one—original types, and Darwinism the explanation of such transformation as a result of natural selection. He quotes from Prof. Zöllner the pregnant utterance that the doctrine of Darwin is "nothing other than the

* Philosophical Consequences of the Lamarck-Darwinian Theory of Development.
† Dr. Bree.

hypothesis of the comprehensibility of organic nature," the sole possible hypothesis, adds the author, unless we are willing to assume—like the Caffres and Arthur Schopenhauer—that "trees and shrubs have sprung up by their own will." It is the carrying out of the *lex continuitatis*, as proposed by Aristoteles and Leibnitz.

In the chapter on Psychology the author refuses to adopt the materialistic explanation of thought and feeling. He quotes the saying of Virchow,* that there is a "materialistic dogmatism, no less than an ecclesiastical, the more dangerous because it denies its own dogmatic nature, appears in the garb of Science, and professes to be experimental where it is really speculative." With Friedrich Harms† he reminds us that a state of motion is not its own perception, a chemical decomposition is not a sensation, nor is a process of combustion, a "glowing" of the brain self-conceptive. Granting vibrations, decompositions, and other mechanical and chemical processes, as existing in the brain, to assume that they furnish an explanation of mental activity proves merely that materialism does not even understand the problem which it believes to have solved.

Very similar is the view of Du Bois-Reymond. "By no conceivable arrangement or undulation of material particles can we throw a bridge into the realm of consciousness."

Thus repelled by the unsatisfactory nature of materialism, certain thinkers have turned their attention to a spiritual monism, of which Bruno is the chief representative. This attempt to find spirit in everything the author thinks not necessary, and takes refuge in the hypothesis of Helmholtz and Sir W. Thomson, who people the earth by the aid of a germ-laden fragment of some ruined world. Surely little reflection is needed to show that this suggestion for the moment evades, but does not solve, the mystery of the first origin of life.

The following considerations of Dr. Von Gizycki merit, however, our warmest approval. He points out how radically our psychology has been vitiated by considering the rest of the animal world as something totally different from ourselves. "Man has thus in a self-deifying spirit misconstrued his position in and his relation to Nature, and has ultimately strayed into anti-natural regions." We forget that humanity includes not merely Plato, Shakespeare, Humboldt, but even the rudest savage. The chasm between the loftiest and the lowest of our species, and that again between the highest and the lowest brute, is still deeper than that which severs the lowest man from the highest animal. Here the author agrees exactly with the conclusions which we, in our turn, have based upon the observations of a life-time. But we may still ask whether these same conclusions do not hold equally good if each animal has had an independent origin?

* Gesammelte Abhandlungen zur wissenschaftlichen Medicin.

† Abhandlungen zur Systematischen Philosophie, p. 266.

In the important chapter on Morality the author remarks that the "significance of Evolutionism for morals is to be found not so much in the circumstance that it leads to certain isolated doctrines as in the elimination of everything unnatural or anti-natural which it introduces into the consideration of ethical questions." The recognition of man's true place in Nature is the last and decisive blow at the mediæval-monastic system of life, and consequently at asceticism in its every manifestation.

Among the more special ethical consequences of Evolutionism must be reckoned a new code as regards our treatment of the lower animals. If we still, as a painful necessity, are compelled to sacrifice life to our safety and in the pursuit of knowledge, the time will assuredly come when we shall be ashamed of the very word "sport," as expressing the infliction of pain and death for amusement.

An ethical doctrine implicated is the so-called freedom of will —the assumption that the voluntary actions of mankind are not subject to the law of causality. The author shows that everything which endears to us the idea of liberty is in reality unaffected by philosophic determinism. It has repeatedly been pointed out in the "Journal of Science" that our right to eliminate beast or man dangerous to human society is all the stronger if the offender pleads necessity.

An important consequence of the doctrine of development is that well-being is recognised as the object of life, and that actions are considered good or evil in so far as they promote or frustrate this great end—a criterion substantially agreeing with that of Herbert Spencer. The author remarks that the fundamental error of eudæmonism or egotism raised to a system lies in its neglect of the sympathetic emotions which centre in others.

The last and perhaps the most important section, the relation of Evolutionism to religion, scarcely falls within our province. The author remarks that Natural Science is hostile to all teleology which views the "mechanism of Nature" as something foreign and external. It would be a lamentable contraction of our spiritual wealth if we renounced the part played by religion in life. But the author is convinced that the *gloria in excelsis* will resound through the ages so long as a human nerve quivers in response to the sublime.

We must here conclude our brief survey of this important treatise. We consider that the author has brought to his task learning equally wide and accurate, and that he has thrown a welcome light on some of the most complicated questions of the day. To quote the significant passages with which his pages are crowded would be to translate the work *in extenso*.

Conscious Matter, or the Physical and the Psychical universally in Causal Connection. By W. Stewart Duncan. London: D. Bogue.

We have here a work which may, to a certain extent, be regarded as a continuation of two articles contributed by the author to the "Journal of Science" (1878, pp. 186 and 385).

Mr. Duncan undertakes to "remove certain barriers to the progress of Modern Psychology; to repel certain objections and to suggest a slight re-arrangement of its tenets, to enable it to harmonise with physical science." He informs us that the existence of a substantive entity, inhabiting the body of a living man, but distinct altogether from the matter of which such body is composed,—in other words, of a soul,—in which alone mental experience can arise, and from which alone volition proceeds, though widely held by metaphysicians, by the clergy, and the unscientific laity, "is almost, if not quite, universally rejected by experts in that department of biology which compares and describes the structures and functions of nervous organisation in man and the lower animals." In favour of this view he cites the published utterances of Mr. Douglas Spalding, of Professor Allman, of Drs. Maudsley and Bastian, of Prof. Bain, and even of Prof. St. George Mivart. Hence, according to the teachings of modern psychology, if correctly represented by these eminent men, "the immaterial soul, considered as a substance numerically and essentially distinct from that of which a material organism is composed, namely matter, is a non-entity, a mere myth."

Prof. Allman, however, points out a "weak point" in the generalisation which refers consciousness as well as life to a common material source, namely, that there is no analogy between mental and physical phenomena. "Even irritability," the Professor adds, "to which, on a superficial view, consciousness may seem related, is as absolutely distinct as it is from any of the ordinary phenomena of matter."

A second objection is drawn from the automatic or unconscious acts of men and animals, from which it has been inferred that "the physical processes in nerve-action were complete in themselves, without the necessary intervention of any mental action or condition." The third difficulty is to account for the persistence of the individual self, while the particles of matter of which it was said to be composed were believed to be continually passing out of the body and being replaced by new particles.

To these objections, then, Mr. Duncan addresses himself. He points out that the term "physical" has been used in three senses, implying "the play of forces, or the equilibrium of forces as such," considered apart from matter; secondly, it has been applied to matter by itself, apart from either force or feeling;

and thirdly, it is used of matter and force in union, as when we speak of moving bodies." There has been also an ambiguity in the terms "mind" or "mental," and hence has arisen a confusion in contrasting "mind with matter," so that it became doubtful wherein the relevancy of the antithesis consists. The author considers it as inconsistent to say "mind is opposed to matter" as to say "dynamics is opposed to matter." He holds the terms "objective" or "non-ego" as altogether out of court, and recognises in each living man, and therefore in all matter, two phases—the one *mental, conscious, feeling;* the other *active, energising, dynamical, physical.* Between these two phases or properties he then proceeds to point out analogies. To these we must especially invite the attention of the student, since, if they can be proved to be erroneous or counterbalanced by points of distinction, the author's attempt to bridge the chasm between physical and psychological science must be regarded as a failure. The first point of resemblance is that feeling and force are alike in themselves destitute of space extension. They are both, however, related to that which is extended, namely, matter. They may both be spoken of in the plural number. They have each the character of diversity applicable to them, and have each the quality of duration. They have each the quality of degree; they are respectively capable of being combined. Feelings and forces are transmutable into other feelings and forces. An equilibrating tendency and centralisation are characteristic of both feelings and forces. They are each measurable as to quantity or intensity. Lastly, force is often measured by its "companion property feeling, and feeling by its companion property force. The contrasts between feelings or forces, the author considers, are not greater than occur between two mental states.

In opposition to the well-known theory of "concomitance," which holds that molecular motions and states of consciousness are produced simultaneously, the author proposes the theory of "alternation." "The time of occurrence of the mental state is when any body, particle, or part of matter is in the attitude of receiving force."

In meeting possible objections to this new theory, the author is led to views on the constitution of matter which may possibly be deemed heretical. He holds that what we call "body" is merely a group of forces, more or less complex, in equilibrium. Motion he regards "not as really a translation of matter, but simply a translation of force-groups throughout continuous and universal matter." The human "Ego," the individual personality, he defines as "the psychical compound, the compound of feelings connected with every body, organic or inorganic." The so-called material change, so far from being opposed to the persistence of the Ego, is, rightly considered, necessary to such persistence. Mr. Duncan holds, however, that "with death each human Ego perishes." Observing how widely and increasingly

human immortality is denied by modern psychologists, we cannot help thinking that the demonstration of a continued existence of the individual after the phenomenon known as death would be the most splendid service which could be rendered to Science.

Those of our readers who wish for a further acquaintance with this little work, abounding as it does in matter worthy of the most serious study, will do well to re-peruse the author's two memoirs in the "Journal of Science" above referred to.

The Natural Conditions of Existence as they affect Animal Life. By Karl Semper, Professor of (? at) the University of Würzburg. London: C. Kegan Paul and Co.

The original German edition of this interesting work has been made the subject of an article in our December number for last year. Hence we can say but little on the version now before us. The translator supplies a valuable note showing that, contrary to Prof. Semper's opinion, carbonic acid has been actually decomposed by green-coloured animals. But we dissent here from the author's reasoning; if a substance presents the elementary composition of chlorophyll, and displays the same chemical reactions and spectroscopic characters, we do not see that its ability or inability to decompose chlorophyll under the influence of sunlight is an essential question. That it possesses this property when forming part of the living vegetable tissue is scarcely a sufficient proof that the same result must be produced under very different circumstances. That chlorophyll acts as an organ in plants does not warrant us in concluding that its functions, if present in animals, must be the same.

As regards Mr. Buxton's interesting experiment of allowing tropical cockatoos to live in the open air in England, we must remark that the winter of 1867-68 was unusually mild, the greatest cold recorded by a thermometer fixed in the wood being only about 29° F. Such experiments, owing to the bird-murdering propensities of the British public, can only be attempted by the proprietors of extensive domains, and we share Prof. Semper's regret that on Mr. Buxton's death the observations were brought to an end. The facts already noticed warrant at least a supicion that many of the more splendid forms of animal life may have been extirpated in higher latitudes not so much by the direct action of cold as by the difficulty of finding, during the winter season, food and shelter from enemies.

In a note the author, referring to the question whether similar organic forms can be derived from independent parent-stocks,

speaks of "that extreme and dogmatic form of Darwinism which in Germany has been designated as Haeckelism." Between Profs. Haeckel and Semper there is, to use a homely old phrase, "no love lost." As instance we may refer to Prof. Semper's work, "Haeckelismus in der Zoologie" (Hamburg, 1876), and to the Preface to the third edition of Prof. Haeckel's "Evolution of Man," which may be consulted in the English version (London: C. Kegan Paul and Co., 1879). One bone of contention between these two authorities is, that whilst Prof. Haeckel seeks to derive the Vertebrates from the *Amphioxus*, Prof. Semper seeks their parentage among the Annelida. Indeed the mutual relations among the chiefs of the new school of Natural History in Germany are much less amicable than might be desired.

For our general estimate of the work before us the reader must be referred to our December number. We regret having to add that the translator has not always succeeded in rendering the original into idiomatic English. We read, *e.g.*, that *Nestor mirabilis*, of New Zealand, "sips the most minute wounds on a living sheep." Again, "Dr. Günther, *in* London, has lately made a remarkable attempt to explain," &c.: "*of* London" would be the customary English expression. These and other inaccuracies and inelegancies will, we trust, be corrected in any future edition.

We are, however, very glad to find that Prof. Semper's work has been made accessible to the many English naturalists who do not read German.

Report of the United States Geological Survey of the Territ ries Vol. XII. Washington: Government Printing-Office.

This volume is devoted to Dr. Joseph Leidy's monograph of the Fresh-water Rhizopods of North America—a tribe of beings which, though exceedingly minute, are of high importance as being probably the starting-point of animal life in point of time, and as rock-formers are of unsurpassed importance in the economy of Nature. The author describes upwards of a hundred species. There are forty-seven plates, some of them containing as many as forty well-executed figures, mostly coloured. Prof. Leidy notes that the Rhizopods, like many other minute forms both of animal and vegetable life, though often abundant in the light superficial ooze at the bottom of still waters, never penetrate into the deep black mud, a medium unfavourable to organisms of every kind.

The thoroughness of this work makes us the more regret that it is mentioned as one of the "final" reports of the Survey,—

final, not because the task is completed, but because its operations are no longer to be conducted on the same magnificent scale.

Ideal Chemistry. A Lecture by Sir B. C. BRODIE, Bart., D.C.L., F.R.S., Professor of Chemistry in the University of Oxford. London: Macmillan and Co.

SIGNAL as have been the triumphs, in our times, of purely experimental science, they do not satisfy the cravings of the human mind. On all hands we perceive a disposition to forestall the results of an appeal to facts, and to outrun what has been demonstrated. In how far such anticipations may prove to be truthful foreshadowings of the future, or, on the contrary, in how far they may have to be rejected as mere *ignes fatui*, time alone can decide.

The great philosophic problem of chemistry is now the question of the elements. Are they really and in truth primordially distinct bodies? Are any of them compounds of the others, more intimate than those we are in the habit of decomposing, and recombining in our laboratories? Or are all of them resolvable into some more truly elemental elements, or even element of which we as yet know nothing? Are they the survivors of a process of natural selection, existing because in harmony with their surroundings? These and many more queries are put none the less eagerly because so far every key with which we try to unlock the mystery breaks in our hands. Sir B. C. Brodie suggests that "in remote time, or in remote space, there did exist formerly, or possibly do exist now, certain simpler forms of matter than we find on the surface of the globe." Of these bodies such elements as hydrogen and mercury are records remaining to us. He supposes that when the temperature of matter was much higher than it is now everything existed uncombined and in a gaseous state. As the temperature began to fall, combination set in; water and hydrochloric acid began to exist. The heat still decreasing, certain forms of matter became more permanent and stable, and when once formed could never be decomposed. All this may be supposed; but can it be proved? Does Prof. Brodie take even a step towards the required demonstration? We think not. As far as we are aware this lecture and the author's "Calculus of Chemical Operations" have not proved fruitful.

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

ANTI-VIVISECTIONIST LOGIC.

To the Editor of the Journal of Science.

Sir,—I beg to call your attention to the subjoined extract from the "Medical Press and Circular." The remark of the Rev. Mr. Fisher is a "cabinet specimen" of anti-vivisectionist argument. If the fact that "Life is God's gift to animals" is a valid plea against vivisection, it is equally cogent against the slaughter of animals for food and against the destruction of vermin.—I am, &c.,

Anti-Cant.

"At the forty-first annual meeting of the Scottish Society for the Prevention of Cruelty to Animals, held last week in Edinburgh, Mr. Josiah Livingstone presiding, a report was submitted showing that a large amount of good had been accomplished by the Society's operations during the year, but that the expenditure had considerably exceeded the income. In the course of the proceedings a suggestion that the Society should direct their attention to the question of Vivisection was strongly opposed by Councillor Sloan, who declared that the saving of a single life was of more importance than the lives of all the cats and dogs put together. (Loud hissing, and cries of 'Shame.') He heard ladies hissing, but he said that a single human life was not to be compared to all the cats and dogs that are nursed and pampered in the New Town of Edinburgh. (Cries of 'Shame,' and the Rev. Mr. Fisher—'Life is God's gift to animals as well as to you.') He did not wish to sanction cruelty, but were the discoveries of scientific men like Dr. Keith and others to be baulked by mere sentiment? He was sorry to see people who, before they would give up pampered, wheezing brutes for scientific purposes, would rather give up their domestics. (Hissing, and great interruption.) The suggestion was ultimately agreed to, as were several others of a like character."

THE SOCIETY OF ARTS AND SANITARY MOVEMENTS.

To the Editor of the Journal of Science.

Sir,—Can you, or any of your correspondents, inform me whether the Society of Arts is, strictly speaking, keeping within the sphere of its duties and functions when it enters upon sanitary questions?—I am, &c.,

Suum Cuique.

[We are unable to answer the difficult and delicate question raised by our correspondent. We should recommend him to take counsel's opinion on the Society's Charter of Incorporation.—Ed. J. S.]

UNPLEASANT ALTERNATIVES,

To the Editor of the Journal of Science.

Sir,—The "unpleasant alternative" will be altogether avoided, and "Verifier" will be enlightened as to how the Indian juggler performs the trick, if he will apply to any conjuror.—I am, &c.,

Saltburn.

NOTES.

M. E. Brandt has laid before the Academy of Sciences an account of his very elaborate researches on the nervous system of the different orders of insects. He has examined 235 species of Coleoptera in their perfect state, and 36 in the state of larvæ. He finds that in some (*Rhizotrogus solstitialis*) the subœsophagian ganglion is blended with the thoracic. The cerebral ganglia have always convolutions. There are from one to three thoracic ganglia. The abdominal ganglia vary from one to eight, the number varying sometimes in the two sexes of the same species. Sometimes, as in the Curculionides and Lamellicornes, there are no distinct abdominal ganglia, but they are blended with the thoracic portion. The author's results on the nervous system of the Hymenoptera were published in the "Comptes Rendus" (lxxxiii., p. 612). All the Lepidoptera have two cephalic ganglia, the upper one having convolutions. There are always four abdominal ganglia, save in *Hepialus humuli*, where there are five. The Diptera have always two distinct cephalic ganglia, the upper being convoluted. The thoracic ganglia vary from one to three, and the abdominal from one to eight, the number sometimes varying according to sex. Sometimes also the abdominal and thoracic ganglia are blended. In the Hemiptera the subœsophagian ganglion is sometimes placed in the thorax: they have never distinct abdominal ganglia.

MM. Garreau and Machelart have extracted from plants of the Saxifrage group an alkaloid which they name benzonine, and which in its physiological action has some resemblance to quinine.

Mr. S. H. Scudder has produced a memoir on the fossil insects from the Devonian of New Brunswick. We make the following extracts from the report given by the "American Naturalist:"— The general type of wing-structure has remained unaltered from the earliest times. Three of these insects (*Gerephemera*, *Homothetus*, and *Xenoneura*) have a neuration differing both from the carboniferous and the modern types. The earliest insects were all hexapod, all hetero-metabolous, and all allied to the Neuroptera. They show marks of affinity to the carboniferous Palæodictyoptera, but are often more complex in structure. They differ remarkably from all other known types, ancient or modern, and some of them appear more complicated than their nearest living allies. While there are some forms which bear out expectations based on the general derivative hypothesis of structural development, there

are others quite unexpected, and not to be explained by that theory without involving suppositions for which no facts can at present be adduced.

Dr. Merriman, writing in " Science," declares—" I believe in the fact of the gradual development of the organic kingdoms ; for all Science teaches it. But I believe it was governed and guided by forces more potent than accident or chance. The Being, or first cause, if you will, that originated the simple elements of matter, and endowed them with the power and the tendency to aggregate into developing worlds, might equally as well have endowed certain of them with the power and the tendency to aggregate into ever-advancing organisms."

Dr. Burrill, in a communication to the American Association for the Advancement of Science, pronounces the " fire-blight " of the pear tree and " twig-blight " of the apple due to an organism similar to, if not identical with, the butyric vibrios of Pasteur and the *Bacillus amylobacter* of Van Tieghem.

It is not generally known that the father of the celebrated chemist Chevreul reached the age of 110 years.

The " American Journal of Microscopy " reports a valuable memoir on " Blood-stains as Evidence in Criminal Cases," read before the St. Louis Medico-Chirurgical Association, by Dr. C. O. Curtman. The author shows that the popular notion of the discrimination of human blood from that of other Mammalia by microscopic and spectroscopic evidence is erroneous. The blood-discs of the dog approach so nearly in size and shape to those of man that they cannot be discriminated with certainty, even when fresh. Blood-corpuscles taken from a mosquito up to forty-eight hours after imbibition could be easily recognised. In the body of the bed-bug blood is destroyed much more rapidly.

Dr. E. L. Trouessart defends the theory of Evolution in the " Revue Scientifique " for October, 1880. He contends that transformations have occurred more rapidly under certain circumstances than under others, and that the changes may have occurred during embryonic life. He refers to the writings of Selys-Longchamp on " Saltatory Evolution."

According to a memoir by Prof. Virchow, which appears in the " Medical Times," medical literature affords examples of a true external tail in the human species, resulting from a prolongation of the spinal column. One of these cases, examined by Dr. Ornstein, Surgeon-in-Chief of the Greek Army, was 5 centimetres in length, whilst another, examined by Virchow himself, reached the length of 7½ centimetres.

According to Prof. Bouchardat, of the Faculté de Medecine, the vine is a powerful sanitary agent. Wherever it is largely cultivated the effluvia which give rise to intermittents disappear.

Mr. H. H. Howorth, in the "Geological Magazine" for December, 1880, argues that, at the epoch of the mammoth, Siberia enjoyed a climate not indeed tropical, but very much milder than is experienced at present.

Prof. Issol, writing in the same journal, shows that the Galita Islands, to the north of Turin, are a prolongation of the granitic mountains of Sardinia.

Mr. Melvin, in a paper read before the Geological Society of Edinburgh, calls attention to the evidence supplied by the vegetable soil as to geological time. He considers that the state of the earth's surface supplies no proof that the arable mould in one hemisphere is older than in the other.

Mr. D. Milne-Home, in his valedictory address to the same Society, stated that in all branches of Natural History, save in Geology, the field for discovery in Great Britain will soon have been thoroughly exhausted.

The "American Naturalist" quotes the Rev. R. B. Watson as stating that there are molluscous species whose distribution is cosmopolitan, and in which no traces of essential, lasting, and progressive change are to be found.

Prof. A. Hyatt, at the last meeting of the American Association for the Advancement of Science, gave a lecture on the transformation of *Planorbis* as illustrative of the evolution of species. The lecturer denied that the Darwinian hypothesis is supported by all naturalists who accept Evolution, and pointed out that it cannot be the primary cause of the variations.

The "American Naturalist" of December, 1880, has a valuable paper on the "Extinct Cats of America," by E. D. Cope, and a continuation of Mr. C. Sedgwick Minot's "Sketch of Comparative Embryology," in which he expounds the general principles of development.

In Brooklyn a man died from the effects of eating trichinised ham, and his widow sued the vendors for damages. The judge raised the question whether it was an ordinary custom to eat raw meat, and whether provision-merchants were bound to supply ham fit to be consumed in such a manner? At the trial Mr. Atwood stated that he had detected trichinæ in the flesh of poultry. Oxen obtain trichinæ from infected water and from grass manured with slaughter-house refuse. The "American Journal of Microscopy" rightly thinks that there is no safety except in the disuse of underdone meat.

M. A. Milne-Edwards has laid before the Academy of Sciences a report on the animals collected on the eastern coast of Madagascar by M. Humblot. He has brought over a pair of living aye-ayes, a species interesting as connecting the lemurs with the rodents.

MM. J. Macé and W. Nicati communicate to the "Comptes Rendus" the results of their researches on colour-blindness. In some cases they find the perception of red deficient, that of yellow normal, and that of green more acute than in the healthy eye. In others the perception of red is abnormally acute; that of yellow, blue, and violet normal, but that of green enfeebled. Hence the authors reject the theory of Hering, who assumes the presence of two distinct photo-chemical substances in the eye, the one serving for the perception of red and green, and the other of yellow and blue. They consider that there are in the retina three photo-chemical substances, corresponding to the three fundamental colours of Young and Maxwell—*i.e.*, red, green, and violet.

M. Lichtenstein reports, to the Academy of Sciences, on the *Phylloxera*. He thinks the insect-enemies of this invader not sufficiently numerous to be of great value. He is engaged with experiments on certain insecticide Fungi, such as *Empusa muscæ*, but the results as yet are not decisive.

M. S. Jourdain considers the inner pair of antennæ in certain Crustacea as undoubtedly organs of sensation, but in default of special experimentation he does not feel justified in pronouncing them the seat of smell.

According to M. H. Viallanes ("Comptes Rendus") there exists under the hypoderm of insects a very rich plexus of ganglionic cellules, connected with the nervous centres, and giving off sensitive terminal nerve-ramifications.

Visibility of Minute Objects.—Prof. Abbe recommends monobromide of naphthaline for mounting diatoms as less inconvenient than the substances used by Mr. J. W. Stephenson (bisulphide carbon, with or without phosphorus, or sulphur in solution). The liquid is colourless and oleaginous, with the odour of naphthaline. It is soluble in alcohol and ether, and has a density of 1·555, with a refractive index of 1·658, giving therefore, as the "index of visibility," 22 as against 11 for Canada balsam. It is not volatile. The cover glass should be run round with a ring of wax; then with a cement of isinglass dissolved in spirit, or Canada balsam, rather thick, dissolved in chloroform; finally closing with a solution of shellac.

The following preservative fluid is given in the "American Journal of Microscopy" (vol. v., pp. 185, 186):—Two parts of salicylic acid and one part of borax, dissolved in a sufficient quantity of glycerin, and diluted as the nature of the tissue to be preserved may require. Preparations so mounted are said to be very durable, and there is no danger of the salts crystallising out and spoiling the object.

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THE

JOURNAL OF SCIENCE.

MARCH, 1881.

I. THE EVOLUTION OF THE SPHERES.

By Charles Morris.

IN the "Journal of Science" for October, 1880, the writer advanced a hypothesis from which necessarily arise several interesting conclusions. The hypothesis referred to briefly declares that "directive force is an attribute of motion, not of matter; that attraction appears when motions are parallel or convergent; and that repulsion appears when motions are reversely parallel or divergent." The evidences in favour of this hypothesis were given in the article mentioned. I wish now to deduce certain necessary consequences from such a law of force.

All theories of the origin of the existing universe are based on the former existence of matter in a more diffused and disintegrate condition than at present. It is very probable, however, that this diffusion never extended to a state of complete homogeneity. Yet a logical tracing back of the visible steps of the evolution of the cosmical spheres leads to a possible homogeneous and completely disintegrated state of matter as its original condition, and arguments of evolution may be based on such a conceivable primary stage.

If matter then, in the whole, or in any widely extended region of space, once existed in a state of complete diffusion, it becomes a question how the action of force could ever bring it into its present condition of partial condensation. In other words, how could the existing heterogeneous arrangement of matter have arisen from an original homogeneity? The hypothesis which claims that all force is the

energy of impact of moving matter utterly fails to explain such a change in condition. For in homogeneous matter every moving particle must strike upon and be repelled by an equal number of moving particles in every direction. Its variations in direction must therefore balance each other, and it cannot permanently change its position in space. If every particle thus continue to be confined to a fixed locality there can be no change in the state of diffusion, and the homogeneous state cannot become a heterogeneous one.

Nor could an attractive attribute of matter produce a change in condition in homogeneous matter, since attraction would act equally from all sides, and thus its influence become neutralised. As to attraction and repulsion existing together in such homogeneous matter, the proposition is unthinkable. Only in the above-named hypothesis does there seem to be a ready means of escape from such a condition. If attraction and repulsion be attributes of motion, the one changing to the other as motion reverses its direction, then, in completely homogeneous matter composed of moving particles, these forces should be neutralised, since the divergent and the convergent motions must balance each other, and no excess of gravitative force could exist. But another result would necessarily appear. The attracting motions would tend to approach, the repelling motions to separate But attraction strengthens with approach; repulsion weakens with separation. Therefore a necessary result of the action of these two modes of force must be to immediately give the attractive a more vigorous influence than the repulsive energies.

And from this there springs another result, of equal importance, namely, a sorting out of the attractive and repulsive motions. The former would tend to aggregate, and to drive the latter from their midst. And these latter would be in accord with other motions, towards which they would be attracted. Hence it seems as if there must have arisen minor aggregations of matter, in each such aggregation the similar motions being in excess of the reverse motions. And such aggregations would tend to separate from each other, or to combine into larger aggregations, according as their general directions of motion were similar or dissimilar, and their influence upon each other attractive or repulsive.

Such being a conceivable original mode of integration, it may be possible to show that it is the only mode, and that all the aggregations of matter, up to the present time, have arisen in the manner here indicated, though the essential simplicity of the process is concealed from us by its

diversified forms. The declaration that a mass of moving particles has an excess of motion in one direction is equivalent to saying that the particles move together as a mass in that direction. It is precisely the same result as occurs when the heat-vibrations of molecules become converted into mass motion, through their vibrations having superior vigour in one direction. Such an aggregation of similarly moving particles, therefore, enables the particles to escape from their fixed positions in space. Mass motion arises out of the original individual motions of particles.

This change in the original condition of matter is necessarily a progressive one. The essential advantage which attraction possesses over repulsion must produce a continuous effect. In the original aggregations the similar may have only slightly exceeded the reverse motions. But as the moving particles approached, through this excess of attractive vigour, the increasing energy of attraction must have constantly tended to bring them into more accordant relations. Particularly when these individual attractions converged to form a general centre of attraction would the accordant motions be drawn towards this centre, the discordant repelled from it. Thus in each aggregation there would arise a growing excess of similar directed motions, or, in other words, a growing rapidity of mass motion.

To what extent this aggregation of similar and repulsion of reverse motions would proceed, it is impossible to say; but we can perceive the probability of the assembling of such like aggregations until wide regions of space might be occupied by matter having an excess of motion in one direction, and other wide regions with an excess in the opposite direction. If the attractions and repulsions between particles were originally neutralised through their motions being equal in all directions, the attractions and repulsions of the masses of the universe would still be neutralised by this sorting out of directions of motion, the excess motion of each mass of matter in one direction being balanced by an equal excess motion of another mass in the opposite direction. Instead, then, of there being a universal gravitation, there would be a universal neutrality of directive force—the original neutrality between particles becoming a final neutrality between spheres.

But in each separate mass, considered by itself, attraction would be in excess of repulsion, since the accordant motions would be in excess of the reverse. And the force of this excess attraction must act to produce condensation of the mass, with an increased excess of accordant motions, and a

forcing outward of the reverse motions, the superiority of attraction over repulsion thus constantly augmenting. Thus great waves of matter would begin to move through space, their rapidity of motion increasing as this process continued, every addition to the excess of parallel motions being an addition to the vigour of mass motions.

Such accordance of motion could only arise through a loss of the reverse motions. A particle so related to surrounding forces that it is obliged to move with equal vigour successively in two opposite directions, can gain an excess of motion in one direction only by a loss in the opposing force in that direction, or increased vigour of the opposite force. It must receive this new energy from some impacting substance, or it must in some manner lose a portion of its reverse movement.

This loss cannot well arise through impact. The particles of a sphere strike vigorously in every direction. But their greatest vigour of impact is in the direction of movement of the mass. Therefore loss through impact would tend to bring the mass to rest. But the resistance to impact of ethereal matter is so slight that its effect is inappreciable. Another mode of loss is through radiation. This is an efficient method of loss of the internal energies of spheres, the matter of space freely receiving radiated motion. Yet radiation takes place equally from the whole surface of the mass, and therefore has no effect on its mass motion.

But in every mass, if accordant motions attract and discordant motions repel each other, every movement in harmony with the general direction must be drawn towards the centre, its line of movement gaining a centrifugal curve. Every motion opposite to the general direction must be repelled from the centre, its line of movement gaining a centrifugal curve.* Thus in every mass that possesses an excess of motion in one direction, and therefore an excess of attraction over repulsion, all accordant motions must converge towards, all discordant motions diverge from, the centre. This sorting-out process incessantly continues, the reverse movements slowly travelling outwards, the parallel motions travelling inwards. Condensation of the mass is a necessary consequence, and also its movement as a whole,

* One consequence of this is that the impact energy of accordant motions must have a slight excess in the direction of the centre, that of discordant motions must be in excess outwardly. Every stroke of an attracted particle is partly directed inwards by gravitation; every stroke of a repelled particle is partly directed outwards. However slight this may be, it is a continuous effect, and must give the accordant energies a constant centripetal advantage over the discordant.

for the motions of its particles in one direction are all retained, while those in the opposite direction are gradually lost. This process must be most efficacious at the centre, its vigour decreasing outwardly. It may be, then, that at the centres of many of the spheres all reverse motion has been lost, and only the mass motion retained. In such a case an absolute zero of temperature would exist at the centre. At the surface of the spheres the greatest quantity of reverse motion would exist, the atmosphere being its final recipient in its outward flow, and also yielding it less rapidly from the decrease in repulsive energy.

In this way the motions of the great bodies of space may have originated. Minor aggregations of accordant motions combined into great aggregations. Masses discordant in motion repelled each other, leaving a region of disintegrated matter between them. Motion of these masses through space increased in rapidity as reverse motion was repelled. As motions became more and more parallel, condensation increased. This, again, caused a rapid increase in the vigour of attractive energy, and also a more vigorous repulsion of the reverse motions, so that at once there arose a greater rapidity of mass motion, a more vigorous gravitation, and a more rapid reduction of temperature.

The mass as yet, however, would be cylindrical, not globular. Its attractions would converge to an axis, with only a somewhat stronger vigour at the central point of this axis. There would, however, be a growing excess of vigour of the centre over the axis as the mass became more condensed. And as minor aggregations into atoms and molecules arose in the mass, the attractive vigour of the internal motions of these would converge to the centre. In consequence the central must constantly grow in vigour over the axial attraction, and the cylinder change more and more into the globular figure. And now the inward curve of accordant motions would be directed towards the centre, with a tendency to rotate around it. But such motions might balance each other in every accordant direction, so that the tendency to rotate in any direction around the centre would be opposed by the opposite tendency. Yet, although the temperature motions in the mass as a whole might be balanced in direction, it is quite probable that they would not be homogeneous in distribution, and that positive movements might arise, to be balanced elsewhere by reverse positive movements. Such a wind of positive motion arising near the centre, in the region of strongest attraction, would have a more vigorous preservative influence than more

distant movements. Its tendency to rotate around the centre would therefore have an excess of vigour over the opposite tendency of more distant movements, less influenced by gravity. Thus a positive motion of rotation would ensue. And from this would at once arise a new excess of attractive energy, all motions parallel to the rotation being drawn inwards, all reverse motions driven outwards, until finally the central rotation communicated itself to the whole mass. And as this vigour of rotation increased, through repulsion of the opposite motions, the movement of the mass through space would slowly cease to gain new vigour, the secondary process of evolution finally quite taking the place of the primary. But the principle involved does not stop here. The production of accordant directions of motion still goes on. Only in the gaseous portions of the earth's material does the energy in excess of that employed in cosmical movements yield irregular motion. Partly in the liquid, and largely in the solid form of matter, this irregularity has been reduced to regularity. The impacting motions, which in the gas move in every direction, in the solid are constrained in direction, the particles, so far as this increment of their motion is concerned, being confined to a fixed locality; and their motions within this limited space are probably in the line of direction of the cosmical motions, since they do not result from impact, except in a minor degree, and are thus free to conform to the attractive influences exerted upon them from without. Other results of the principle of motion which we have here considered appear in the movements of matter in atomic and molecular aggregation. But a consideration of these must be left for a future article.

There are, however, certain cosmical consequences of the hypothesis yet to be considered. It might, for instance, be supposed that in the vast regions of space between the condensed spheres the aggregating principle here advocated would reappear, and new condensations of matter arise. Nor is it impossible that minor aggregations of this kind have arisen: but large aggregations are very unlikely to appear. For the material occupying this space is the receptacle of the vast volumes of moving energy lost as temperature to the condensing spheres. This must act to increase the motive vigour and the diffusion of the matter of space (it expanding to fill the void left by the contracting matter of the spheres), and to reduce the vigour of attraction between its separate particles. Moreover, the motive energy thus poured out from the spheres comes from sources of diverse motions, so that every tendency to produce accordant

motions in the matter of space may be negatived by the reverse motions yielded by the spheres. Thus the force yielding action of the spheres exerts a double influence adverse to the formation of new aggregations of the matter of space.

As to the dimensions of the original aggregations of matter it is impossible to decide. The solar system may be the result of a single nebular aggregation, or it may be a portion of a much greater astral aggregation. Its great separation in space from other solar systems is an argument in favour of the former; and, as we have seen, its motion as a whole through space is no necessary proof of its gravitative connection with other solar systems.

In fact the arguments here given tend to show that gravitation is local, not universal, and that, between the spheres of the whole of space, the repulsive just equal the attractive energies. From this possibility a somewhat striking deduction arises. If our solar system has its free motion through space as a result of its mode of aggregation, and not from original connection with the surrounding systems, it is probable that the general direction of internal motion in each of these systems may differ to some extent from that in the solar system, and that while some may be attractive, others may be repulsive in their influences.

But the motion of our system is as likely to be towards a repelling as an attracting system. We may, therefore, safely question what would happen in the former case. Suppose two such systems to approach each other at the vast speed with which solar systems move through space. Whether moving directly together or not, their repelling energies would act with a rapidly increasing vigour as they came nearer together. And this repulsion must necessarily lessen their rapidity of motion, and might, in extreme cases, bring them to a dead halt. What would result? Their lost motion of translation through space must fall back into their mass, and become heat vibration of their particles, the reversal of motion in one sphere being just balanced by the reversal of motion in the other. As their motion decreased, therefore, their temperature would increase, and this result, in extreme cases, might be sufficient to dissipate the two systems into their original vaporous state. In this hypothesis, then, we perceive one possible mode of disintegration of the spheres, an action which may eventually influence every solar system of the universe, and thus cause an infinitely repeated process of integration and disintegration of spheral masses, instead of a single irreversible process of

evolution from original ether to motionless and dead worlds.

In the case of two attracting systems approaching there would necessarily be a rapid augmentation of the motion of each. But this new motion could only be gained at the expense of the internal temperature of the spheres (as argued in my article on Heat Transformations, in the "Journal of Science" for June, 1880). Thus in two such systems there would be a rapid diminution of temperature, accompanied perhaps by an extreme condensation. But if they should come into contact with each other a result would arise similar to that shown above in the case of two repelling spheres. Their sudden loss of mass motion would yield a sudden increase of heat motion, and disintegration might also, in this case, occur. Thus the hypothesis that force is an attribute of motion yields us the possibility of an infinitely active universe, instead of a finite one, as under the hypothesis that force is an attribute of matter.

Before concluding, however, a certain degree of recapitulation seems desirable. We have argued that in the conceivable original homogeneous diffusion of matter there was an equal balance in the directions of motion, every movement in one direction being somewhere balanced by a movement of equal vigour in the opposite direction. But however heterogeneous the state of matter in the universe, this condition continues necessary. For if, taking the universe as a whole, its sum of motive energy in one general direction should exceed its sum of motive energy in the opposite general direction, the universe must move for ever in that direction, there being no force in existence capable of reversing this excess of energy. Or, if we could imagine the existence of space beyond the material universe, then a section of matter containing this excess motion might separate from the remaining matter, and move eternally onward, leaving the other section of matter in eternal rest. Such a condition of affairs seems inconceivable. But if there is not this eternal movement in one direction of the whole or a portion of the universe, then there must be a balance of its motive energies in every opposite direction. Such a balance, once existing, must be eternal. The universe, once at rest in infinite space, could never begin, of itself, to move through space.

Yet the continued existence of such a balance requires that no particle can gain a movement in any special direction unless some other particle gains an equal opposite movement. And such an exchange always occurs, whatever

the acting force, whether impact, attraction, or repulsion, In every case of impact there is always an equal exchange of momentum. Where the motions of the impacting bodies are reversed, the new paths assumed exactly replace the old paths lost. Where they move together after contact the new path is the exact equivalent of the two former paths. The heavier body necessarily suffers the least change in direction, otherwise the balance would be destroyed.

It is the same with attraction. Attractions are always equal and opposite. Any body moved by attraction causes by its opposite attraction an equal reverse momentum in the acting substance. In repulsion it is the same; both bodies are driven equally from the original path.

If a small mass approach the earth its speed may become extreme, there being an apparent loss of motion in one direction or gain in the other. But the earth moves towards the falling body with equal momentum. Thus the gain of momentum in one direction by the body is precisely equalled by a reverse gain of momentum by the earth, and the great balance of force remains undisturbed. This principle, in fact, cannot be overthrown by any conceivable action of force. The universe is a vast pendulum, where every forward swing of a particle is balanced by a simultaneous backward swing of some other particle, moving with equal vigour.

Necessarily, then, the positive motions now possessed by spheres must be balanced by equal opposite motions possessed by other spheres, or else by an equal excess of motion in the opposite direction possessed by the matter of space. It is into this matter of space that the moving spheres have discharged their reverse motions. The particles of these spheres have thus lost a considerable portion of their original motive energy, yet they retain a large percentage of it. They have lost a part of their motive energy in one direction, and move constantly forward in the opposite direction with a rapidity equal to the rapidity of the lost reverse motion. This may enable us to gain a more definite idea of the rapidity of the original motion. Every particle of the solar system moves through space at a speed of about 250 miles per minute. Every particle of the earth moves around the sun at a speed of 1100 miles per minute. Every particle of the earth's equator moves around the centre at a speed of 17 miles per minute. Yet these excessive speeds only indicate the speed of motion lost in the opposite directions. In addition to this a considerable vigour of reverse motion is still retained, giving every particle rapid individual

movements of vibration. Besides all this energy of molecules as wholes, every molecule or atom is a mass of minuter elements, which very probably possess a rapid centripetal moving energy. The matter of space, therefore, if reduced to a condition of complete disintegration, would possess individual movements of almost inconceivable rapidity. A large percentage of this original motion still exists in spheres, though it is curbed and controlled in direction by the various specializations to which it is subject, and is very largely centralized by centripetal energy, and thus fails to make itself outwardly apparent.

That the matter of space was ever completely disintegrated seems impossible, from the above considerations. More likely there has been incessant integration and disintegration through the influences here specified, so that the existing condition of the universe indicates its eternal condition.

The argument here advanced may lead some readers to the idea of possible future catastrophes. It may be imagined that our premises require sudden changes from a condensed to a nebulous condition in the spheres. Yet no such necessity exists. If the motion of our solar system were directed towards its nearest neighbour in space it would need one million years to reach it, at the present rate of speed. It is really directed towards orbs which it must take many millions of years to reach. If now the influence of these orbs were repulsive, there would be an exceedingly gradual diminution of the motion of our system, and as gradual an augmentation of its heat. Yet this augmentation, being internal as well as external, could not radiate, as fast as produced, into space, and must therefore greatly increase the heat energies of the sun and planets, even if insufficient to reduce them to their original gaseous state.

In the contrary case, of two attractive systems approaching, it is almost infinitely improbable that they would move directly towards each other: therefore they would be very unlikely to come into actual collision, but would curve around each other as a comet curves around the sun. The internal refrigeration caused by their great enhancement of speed in approaching would be succeeded by a regaining of their lost temperature, through decrease of speed in separating.

Thus the idea that the existing mode of evolution in the solar system must be continuous, and lead to a final loss of all the active energy of the spheres, is based on a view that embraces our system only, and leaves out of sight its

neighbours in space. It really has a source of new energy in its motion through space which may, as we have seen, be made available through the attractive or repulsive action of other systems, its process of evolution at one period of time being reversed at another period.

Again, in the case of two repelling spheres bringing each other to rest, with the conversion of their mass motion into heat, a portion of this heat is radiated into space. Therefore on their subsequent separation by repulsion, a part of their former energy of mass motion has been lost, and must be replaced from their original store of heat. Here, then, seems a source of a gradual and irreversible loss of heat into space, which must, after some interminable period, exhaust the available energy of the spheres and limit their activity.

But this loss may be met by a gain in an opposite direction. Attractive spheres will be met as often as repulsive. These, by the excessive increase of speed, may become greatly refrigerated, and receive radiant heat from space instead of radiating into space. Thus the loss of energy in the one case may be balanced by a gain of energy in the other. And finally there may be regions of space of a temperature sufficient to prevent or to reverse the radiations of the spheres.

It seems, then, as if the universe may be organised on a self-regulating principle, all its changes being paralleled by counter-changes, its losses replaced by gains, so that the condition it now displays is a counterpart of the condition it has maintained throughout the eternity of the past, and will maintain throughout the eternity of the future.

II. OFFENSIVE MANUFACTURES: A SUGGESTION.

By An Old Technologist.

MUCH has been already done in the way of rendering certain manufacturing and mining operations less noisome to the general public than was formerly the case. The production of black smoke beyond certain limits is interdicted,—at least if the local authorities choose

to put existing laws in force. The "Alkali Act" has, to a very considerable extent, checked the free emission of acid vapours, and it is probable that further and more comprehensive legislation in the same direction may soon follow. As regards the water-courses, the Rivers' Pollution Act is gradually working an amendment in their condition, which will soon grow apparent if its provisions are not suffered to become a dead letter. In addition to all this, any person who feels himself aggrieved by the refuse of industrial operations sent up into the air, or allowed to drain into the rivers, may, if his means permit, apply for redress to the High Court of Chancery, and, if he can show that definite injury is being done either to his health or to his property, an injunction for the abatement of the nuisance will be issued.

Still all these various remedies leave very much of the evil untouched. Certain kinds of manufactures have been placed under restrictions and inspection, more or less complete and efficient. Other kinds, not less offensive in their results, have not been interfered with. Where the iron trade flourishes vegetation is blighted, the air is polluted, and the light of day blotted out quite as much as in a region of alkali works. The consumption of smoke is not demanded from blast-furnaces, and the quantity of the oxides of sulphur which they pour into the air is simply enormous. Let us take an establishment of this kind which burns 200 tons of coal daily, by no means the maximum consumption. If such coal only contains 1 lb. sulphur per ton,—which is far below the average in Lancashire, Staffordshire, and Warwickshire,—there is given off daily sulphurous anhydride equivalent to 600 lbs. of oil of vitriol, or, taking a year of 300 working days, 180,000 lbs.! As a matter of course all vegetation exposed to acid vapours and acid rain is destroyed. Not the less certain is it that every portion of buildings capable of being affected by acids is corroded. Were such damage wrought by chemical works, complaints would multiply, and legal proceedings would soon be taken. But it seems that the sins of an iron-smelter are more leniently dealt with than those of a chemical manufacturer.

Looking at such facts, and many others of a like kind which might be brought forward, it seems to me very doubtful whether any measure applied in an indiscriminating manner to the whole country can ever meet the just demands of all parties concerned.

We are placed in a dilemma. On the one hand, in a narrow island like Britain, with a cold, weeping, and

precarious climate, manufactures and mining are a necessity for the support of the present population. We must therefore be very cautious how we impose upon manufacturers burdens and restrictions which may render them unable to compete with their foreign rivals. Indeed, what with limitations on the hours of work and with sanitary and philanthropic regulations of various kinds, we have, in the opinion of many persons well able to judge, gone quite far enough, unless our neighbours would follow our example. Hence we can scarcely impose additional restrictions upon the nuisances and eyesores apparently inseparable from the industrial arts. Inseparable, I say, so long at least as coal is the great source of heat and of mechanical power. Could we do away with coal-dust, coal-ashes, coal-smoke, and coal-mines with their hideous "spoil-banks," and obtain motive energy from the rise and fall of the tides, we might take heart.

But, on the other hand, the farmer and gardener have good reason to complain of the destruction of their crops, no small part of the soil of Britain being for food-producing purposes rendered non-existent. All sorts and conditions of men are warranted in protesting against the acidification of the air, the over-clouding of the sky, the soiling of their houses, their clothing, and their persons, and the general making everything—natural or artificial—loathsome and hideous to their senses. How are we to reconcile these two contending necessities?

The way out of this dilemma may be found by a reference to domestic life. In every household there are processes and products, the refuse of cooking, of washing, and of human life itself, which are more or less noisome and unsightly. We cannot dispense with these processes; we cannot prevent the continued formation of such refuse. But we can and do act upon the old principle of a place for everything, and everything in its place. We do not allow the slop-pail or the suds from the washing-tub to stand in a corner of the drawing-room, no matter under what cleverly devised rules and regulations. We do not suffer fish-bones and oyster-shells and the parings of vegetables to be deposited in our libraries or in our consulting-rooms. Nay, what is the circumstance which we most regret in the condition of the poorest classes of our great cities? Is it not that want of space compels them to cook, and wash, and eat, and sleep in one room? Surely the moral of these considerations is plain to be seen. We do, as a nation, what no person in comfortable circumstances does in his house, and what we

see with such pity in the dwellings of the poor—we mix all up together. Custom has rendered this process so familiar to us that many persons cannot even conceive the possibility of allotting out different parts of a country for different purposes, and of having for such parts entirely distinct laws and regulations. Yet that such an arrangement would be for the benefit both of manufacturers and of the rest of the community can be shown beyond the reach of doubt. The manufacturer, within his appointed districts, might enjoy very considerable latitude as regards the escape of fumes, the discharge of polluted waters, or the accumulation of alkali-waste, chrome-waste, spent shales, slags, &c., so long as he occasioned no demonstrable injury to public health. The farmer, on the other hand, in his districts, might plant and sow without the fear of his crops being blighted by corrosive vapours. The country gentleman would not be annoyed by the withering of his woods and plantations, and every man's tastes would be gratified.

It is to be remarked that a certain rough sorting-out of trades and manufactures was effected by nature. The iron-foundry, the cotton- or woollen-mill, the alkali-works, &c., were, from obvious reasons, erected where fuel is cheap,—in other words, on or near to the coal-mining regions. By a fortunate coincidence these districts are generally of little value from an agricultural point of view, and until the rise of manufactures they were very poor and scantily peopled. As little are they noted for beautiful scenery. It would perhaps be difficult to find a tract of country less favoured by nature than South Lancashire; and if its eastern section has become the centre of the cotton-trade, and its western part the head-quarters of some of the largest chemical manufactures in the world, there is an admirable fitness in the localisation. It seems scarcely fair that great land-owners, whose barren and unprofitable acres have been covered with manufacturing towns and villages, should complain of the nuisances incidental to the very trades which have so largely magnified their rent-rolls. They cannot, by any Royal Commission or Act of Parliament whatever, succeed in both keeping their cake and eating it. If they will preserve their fields and trees green, as was the case two centuries ago,—if they aspire to catch trout in the Sankey Brook,—they must be content with the slender rents which fell to the share of their ancestors.

But the natural division which sprang up between manufacturing and agricultural-residential districts is now less well-marked than was the case fifty, or even twenty, years

ago. The greatly improved means of communication have to some extent levelled the cost of fuel over many parts of the kingdom, and have rendered it possible to establish manufactures and to introduce nuisances where it would once have been simply impracticable. If caprice should induce anyone to erect alkali-works in the Isle of Wight, or on the banks of Derwentwater, there is nothing to prevent him, and the laws concerning nuisances—gaseous, liquid, or solid—would not press more severely upon him than at St. Helens or Widnes. There is no authority to say to him "So long as there is abundance of available land where there is nothing to spoil, you shall not come to any place characterised by its beauty or its fertility;" or, returning to the illustration we used above, to bid him put his refuse in the dust-bin, and not in the drawing-room.

The honour of first distinctly enunciating the principle that sanitary laws must be modified according to the existing character of the district belongs unquestionably to Mr. W. Crookes, F.R.S. When giving evidence on the Rivers' Pollution question, before a Committee of the House of Lords, he opposed the notion of a uniform standard of purity for drainage flowing into a river, and contended that the river itself should furnish the standard, nothing worse than itself being allowed to enter. This proposal would render it absolutely impracticable to establish manufactures, *e.g.*, in the Lake District, or along the clear streams of Wales and the North of Scotland, whilst in South Lancashire and certain parts of the West Riding it would allow, for the time being, very considerable latitude. What I have to propose is merely an extended application of the same principle. Let England be divided into two classes of land, A and B. In A let manufacturers, if existing at all, be placed under the most stringent regulations as regards the pollution of the air or the water, or the piling up solid refuse of any kind. Thus the emission of any recognisable amount of hydrochloric acid gas, or of above a certain quantity of sulphurous acid, whether produced by the combustion of coal or otherwise, would be prohibited. The emission of dye, tan, or bleach liquids, &c., of spent dye woods or pulverulent refuse of any kind, riddlings or siftings of coal or other minerals, would have to cease. In districts B, on the contrary, rivers—provided they passed into the sea without flowing through any A district—might legally receive any industrial refuse, provided it neither gave off emanations injurious to human health, or choked up the bed of the stream and tended to cause floods. Smoke consumption

would be carried on so far only as was consistent with economical working. In the case of the escape of gases the same rule would be observed. If a farmer complained of damage to his crops he would then be told that if, of his own free will and choice, he preferred to occupy land in a B district, he must accept the inevitable conditions. In the same way, if a manufacturer thought proper to conduct his operations in an A district, and complained that the conditions required were ruinous, he would be told that by removing into a B district he would meet with every facility. In all this I can see no injustice, since both farmer and manufacturer would be freed from much annoyance to which they are each respectively liable under our existing promiscuous arrangements.

The two kinds of districts could be marked out without much difficulty. Those lands which lie over, among, or near the coal-deposits, or along the tideway of our navigable rivers and along the shore at their mouth, would fall under schedule B. We might include here all Lancashire except the Furness beyond Sands, the eastern half of Northumberland and Durham, the north-eastern margin of Cumberland reaching from Whitehaven to Silloth, the Yorkshire coal-fields, eastern Derbyshire, the whole probably of Staffordshire and Shropshire, the greater part of Warwickshire, and a portion of Worcestershire. In Nottinghamshire and Leicestershire the demarcation might possibly be not free from difficulties. In the London district ample margin might be secured for manufactures within a region beginning about Bow and extending eastwards between the Thames and the Chelmsford branch of the Great Eastern Railway, in addition to a much narrower strip of land on the south side of the Thames and about the mouth of the Medway. The coal-districts of Somerset, of South Wales, and of Flint would complete the B schedule of South Britain. Everyone must confess that within these limits three or four times the amount of manufacturing activity which we now exert could find ample room. The London district, to the north, the west, and the south, would be entirely free from noisome manufactures, whether chemical or mechanical. The southern counties, with the exception of the slip of North Kent just mentioned, would be entirely placed in schedule A. So also would the West, with the exception of the Somerset coal-district and the Cornish mining region. Norfolk, Suffolk (save about the mouth of the Orwell), the greater part of Essex, Cambridgeshire, the greater part of Lincoln, the north-west of Yorkshire, the

west of Durham and Northumberland, all Westmoreland, the greater part of Cumberland, Lonsdale beyond Sands in Lancashire, a considerable part of Cheshire, Derbyshire, Worcestershire, Hereford, and Monmouth, besides the midland counties bordering upon the Thames.

It is by no means suggested that all manufacturers should be proscribed in the A districts. To paper-mills and print-works, so long as they consume their smoke and run no refuse into the rivers, I see no reasonable objection. The same may be said of such chemical works as prepare fine products for photographic and pharmaceutical purposes. Nor need soap-works be banished so long as they do not melt raw tallows or use animal offal. The chief objection is to the alkali manufactories, to iron-, copper-, and lead-smelting works, large foundries, locomotive works, woollen and cotton mills, and all establishments which sulphurise the air by the sheer quantity of coal consumed.

The most rigid limitation should be placed upon the manufacture of explosives, which should be strictly confined to lonely places. It is too often overlooked that when a magazine explodes the shock does not travel merely through the air, but underground, producing in fact a veritable earthquake. In the great gun-cotton explosion at Stowmarket, in August, 1871, windows were observed writhing and falling to pieces at places distant about three-quarters of a mile from the magazine, *before* the sound reached the ears of the amazed spectators. Hence belts of timber, mounds of earth, &c., are of very little value as a protection to any adjacent property in case of a severe explosion. If we consider what havoc was wrought by the explosion of about 50,000 lbs. of gunpowder at Erith, we may feel astonished that the Home-Office should propose to sanction the storage of 10,000 lbs. of an explosive alleged by the patentee to be "from three to four times as strong as gunpowder," at the distance of about half a mile from a valuable dwelling-house.

Those who have had the painful opportunity of observing the effects of a severe explosion can scarcely come to any other conclusion but this, that no manufactory or magazine of explosives, save in the hands of Government, should exist within a clear mile of any human habitation, and that such establishments should moreover be so situated that the products may be delivered to shippers or consumers without the necessity of passing through London or any large city. For such branches of industry special parts of the B district should be set aside.

III. ON LIVING ORGANISMS WITH REFERENCE TO POLLUTED WATERS.

By J. W. Slater.

IT is well known that the late Royal Rivers' Pollution Commission, in consequence of their observations and experiments, concluded that a river if once polluted with fœcal matter does not become purified by any natural process, at least within the length of any stream in the United Kingdom. Dr. Meymott Tidy, from a paper which he has recently communicated to the Chemical Society, holds, on the contrary, the opinion that rivers after contamination with animal or vegetable matter—excrementitious substances being necessarily included—are capable of self-purification, through the instrumentality of subsidence, of the absorption of oxygen, which is the more rapid the more impetuous the current, or by the agency of fish. It can scarcely, I think, be contended that fish can have any power of freeing water from dissolved impurities.

Some years ago an eminent French chemist came to conclusions very similar to those which have been made known by Dr. Tidy. He had proposed to estimate the relative purity of waters by the amount of free oxygen which they hold in solution and which he determined volumetrically by means of a standard solution of the "hydrosulphite" of Schützenberger and De Lalande. Among other waters which he thus examined were those of the river Vesle, above and below Rheims. As this town is the seat of very extensive woollen manufactures, the Vesle is polluted in a very similar manner to the Aire at Leeds, with both organic and inorganic refuse of the most varied kinds. He found that the water at the distance of some miles above the town contained a normal proportion of free oxygen. Approaching to Rheims and receiving the waste liquids of manufactories, it showed a smaller and smaller percentage, and a minimum was reached a little below the town. Afterwards, as the stream continued its course through an open agricultural district, the proportion of oxygen again increased, and at the distance of about twenty miles below Rheims—I quote from memory—it showed the same percentage as had been obtained above the city. At the same time he observed a series of changes in the organic forms inhabiting the river, which in his opinion proceeded step for step with the de-

crease and the subsequent increase of oxygen dissolved in the water. To these charges I must beg to call attention.

Above Rheims various kinds of fish were found in the Vesle, whilst aquatic vegetation of a fairly high type, *i.e.*, capable of secreting chlorophyll, was abundant. Water-weeds grew in the stream, and reeds and sedges flourished at its margin. Near, and especially within the town, these organisms disappeared. The fishes avoided, or perished in this part of the river, and in place of the green plants that inhabited the purer waters, growths devoid of chlorophyll made their appearance, among which figured the true "sewage-fungus." Below the town, as the quality of the water again improved and the percentage of dissolved free oxygen rose, the higher forms both of animal and vegetable life reappeared.

If the observations thus made are generally confirmed, two conclusions not without importance may fairly be drawn:—That the proportion of oxygen in the water of a river is causally and very simply related with the presence of the higher forms of animal and vegetable life; and that from inspection of such organism a tolerable approximate notion may be formed as regards the purity and the impurity of a stream. It has, indeed, been repeatedly asserted in French scientific journals, that water-cress can only grow in fairly good water. This assertion struck me as being little in harmony with my own observations and those of my friends. Mr. C. Cresswell, of Isleworth, a gentleman well-known for his zeal for sanitary reform, came upon a ditch which received the entire sewage and household refuse in general of a row of about a dozen cottages. Yet it was filled with the most luxuriant water-cress, which, sad to say, appeared to be regularly cut for sale. To decide the matter I carried on a somewhat extensive series of experiments at Aylesbury in the summer and autumn of the year 1878. Earth was placed at the bottom of four small movable tanks, and in each were planted healthy roots of water-cress. The tanks were then filled respectively with town sewage, undiluted and taken directly from the sewer-mouth; with water from a branch of the river Thame which flows past the town, receiving the drainage of manured and cultivated lands, and I believe sewage from scattered cottages in the upper part of its course; with sewage after treatment by the "A B C process," *i.e.*, precipitation with sulphate of alumina, clay and carbon; and lastly, with potable water. The loss by evaporation or leakage in each tank was made up by the regular addition of the same kind of water as had been taken

at first. The result did not admit of the slightest doubt: the water-cress planted in sewage not merely lived and grew, but far surpassed the other three lots in luxuriance and vigour, and continued so to do till the experiment was stopped by the frosts in the beginning of winter. Hence it may surely be concluded that the presence of water-cress in any stream or pond affords no proof of the purity of the water. It must be understood, however, that the sewage in question, though rich in fœcal matters, blood from slaughter-houses, &c., was perfectly free from manufacturing refuse. I have never heard of any instance of water-cress being found growing in any stream which receives the waste waters of chemical or dye-works, woollen-factories, &c. But as the sewage in question contained very much less free oxygen in solution than the potable water or the river water, it is plain that the growth of higher vegetation does not follow step by step the rising or falling proportion of oxygen. I may ask, indeed, why should it? It is almost needless to remind the reader that all plants which develope chlorophyll in their tissues liberate oxygen on exposure to sunlight. Hence aquatic vegetation is a cause rather than an effect of the presence of free oxygen in water, and its absence in highly polluted streams is due not to the deficiency of that particular element, but to some positive injurious agency, such as acids, alkalies, metallic salts, &c. In the absence of such plant-destroyers green vegetation is very efficient in freeing water from fœcal impurities. There are, of course, here certain limits; solutions of putrescent organic matter may be too concentrated to admit of vegetable life, just as liquid manures may be applied in too strong a dose. But this is a point rarely reached in any stream, and when chlorophyllaceous vegetation is absent we may generally seek the cause in the waste waters of some manufacturing establishment. Town-sewage when treated by any process which leaves in it a large proportion of any compound of lime, is also unfriendly to aquatic vegetation. The sanitary authorities of a large manufacturing town were advised by the late Mr. Smee to plant *Elodea canadensis* in the outer tank of their sewage-works, and to attempt the growth of reeds and sedges in the shallow waters along its margin. The advice was excellent, inasmuch as such vegetation would have completed the purification of the sewage. But as the process adopted involved the daily use of about fifteen tons of lime, it was not to be wondered at if the plants failed to survive. As far as I have observed, natural streams of very hard water are poor in aquatic vegetation.

But we must now turn to the growth which is considered most characteristic of polluted waters. Everyone talks of "sewage-fungus," and yet there are redoubted "sanitary reformers" and patentees of processes for the purification of sewage who have never seen this dreaded plant, and who suppose that it must have something of the appearance of a mushroom. This is a complete error; in form and colour it is not unlike a bundle of tow, with the fibres running parallel and ending in loose tufts. Suppose such a bundle fixed at one end to a stick or a stone or to the earth at some little depth under water, and swaying to and fro in the current, and you have a very fair resemblance of sewage-fungus. The chief difference is that this unholy and unlovely plant has a greater specific gravity than hemp, and tends to sink rather than rise if not kept in a horizontal position by the stream. The colour, too, is modified by the particles of dirt which get entangled in the fibres. What concerns us are neither the structure, nor the affinities, nor the chemical composition of this fungus, but the conditions under which it exists and its value as a sign of water-pollution. It is, in the first place, as far as I have been able to see and to learn, peculiar to running water. I have never seen it at the sides of any pond or reservoir whether of pure or of polluted water, nor at the bottom of such pools when emptied. If planted in an aquarium for experimental purposes it hangs straight down from the stick or root to which it has been found attached, and whether kept in the light or the dark it shows no disposition to flourish. Moving water is, therefore, essential to its growth. If preserved in the dark, however, it undergoes no change for months, and seems unaffected by the most powerful chemical agents except in enormous proportions. Chromic acid, for instance, is not reduced by it even on prolonged contact. If, however, sewage-fungus is placed in still water and exposed to strong light, green confervæ fix themselves upon it, overspread it, and seem gradually to effect its destruction. I have observed similar cases in shallow trenches in which partially purified sewage was flowing, but where water is still strongly charged with animal matter the fugus appears to hold its own, especially if the depth and turbidity of the stream interfere with the free action of light. It need scarcely be said that sewage-fungus is never found in pure mountain streams, or even in the brooks and ditches of rural districts which receive the drainage of cultivated lands, except they are connected with some sewer. But if portions of the plant are swept down out of a sewer—*e.g.*, by a violent storm of rain

—they are able to live in running water where the amount of pollution is exceedingly small—much smaller than the proportion specified as to be tolerated in the "recommendations" of the Rivers' Pollution Commission. If it be asked how this is ascertained, I reply that I know a small stream which down to a certain point is perfectly free from sewage-fungus, as I have satisfied myself by frequent and careful inspection. At that point it receives a stream of sewage, about one-sixth of its own volume, and purified to such an extent that one of the highest authorities on water-analysis, after repeatedly examining samples taken at haphazard, has pronounced it to fall well within the limits of the recommendations just referred to. Yet the stream, after receiving this infinitesimal proportion of fœcal matter displays here and there a tuft of sewage-fungus, along with a most luxuriant growth of green water-plants. It must further be noticed that on pursuing the stream for a few hundred yards the fungus disappears, its pabulum having possibly been destroyed by the oxygen evolved by the higher vegetation.

But whilst water may thus be too pure to supply the trace of nitrogenous nourishment required by sewage-fungus, it may be found, if not too impure, at least not to possess the right kind of impurity. I have made frequent and minute examinations of the sewage of Leeds, and of the results of the various processes which have been adopted for its purification, but I have never seen a trace of sewage-fungus either brought down the sewers from the town, or floating in the tanks, or fixed in the cut-flow channel, or where the latter opens into the river Aire. This absence was equally distinct whatever was the nature and the success of the process adopted.

Again, the London sewage at the southern outfall has never, in as far as I have had the opportunity of observing, contained a particle of sewage-fungus.

The same may be said of the sewage of Paris, which I have had prolonged opportunities of examining at Gennevilliers. On the other hand, a ditch at Wimbledon which received the sewage of the district, some of it treated and some in its original state, contained in the autumn of 1875 some beautifully characteristic specimens. At Aylesbury, after heavy rain, it has been swept down from the sewers of the town in great quantities, and at Hertford it has also been observed in great perfection.

Hence we may probably conclude that it grows by preference in the rich sewage of small residential towns rather than in the waste waters of the great manufacturing centres,

or in the dilute sewage of London and Paris. When once established, however, it is able to live on in relatively pure water, It need scarcely be said that this fungus, containing no chlorophyll, gives off no oxygen on exposure to light, and consequently contributes nothing to the purification of the water which it inhabits. It does, of course, withdraw a certain amount of organic matter from the water to form its own tissues, but this on its ultimate decomposition is restored to the stream. I am not aware that it is ever eaten by any animal—certainly not by fishes, insects, crustaceans, or mollusca. Infusoria swarm among its fibres, but probably as a place of shelter. Nor can I learn that it has ever been tried as an article of human diet. It might not be impertinent to express the wish that a certain gentleman who wrote to the papers proposing rats—foci of *trichinæ!*—as food for the destitute, would kindly make an experiment on sewage-fungus *in corpore vilissimo*. It is certainly nitrogenous, possibly nutritious and delicate, and just as possibly poisonous. I have frequently found this fungus growing to the bodies of dead fishes, floating in streams of doubtful purity, and I fear it is capable of attaching itself to these creatures whilst still living and bringing about their death.

We have now to turn to the animal world and ask whether the presence or absence of fishes can be said, in general terms, to be solely and mainly dependent upon the greater or smaller proportion of free oxygen in the water? That such oxygen is an essential of life for them must be known even to the most careless proprietor of an aquarium. We may therefore say that if oxygen is wanting fishes will be wanting also. But can we draw the converse inference, that if fish are wanting oxygen must be deficient? By no means; there are various substances which occasionally find their way into rivers, and which prove very extensively destructive to fish, but which are not likely to effect any decrease in the proportion of dissolved oxygen. We may take an instance given on very good authority, and briefly noticed in the "Journal of Science" for 1880, page 213. Dr. Auerbach, during an entire summer observed certain water-beetles—from his description probably the "whirligig" (*Gyrinus natator*)—living in tanks full of a saturated solution of sodium sulphate (Glauber's salt). When alarmed these little beetles dived down and took refuge among the crystals that were forming, just as they would do among the water-plants in a pool. But a little of this liquid, thus harmless to insects, happened to escape from the tanks by leakage and found its way along a ditch into a river at some distance,

where it proved fatal to a multitude of fish. It can certainly not be contended that a small quantity of such a solution, added to the water of a river, would either seize hold of and expel the free oxygen; yet we see that it turned the scale between life and death.

Cream of lime thrown into a stream will, as is known, seize upon carbonic acid, leaving oxygen unaffected. Yet this addition is well known as fatal to fish.

The presence of fish is certainly no proof of the absence of fœcal matter. At Kingston, just where the sewage of the town entered the Thames in 1875—it may possibly since have been diverted—I have seen fish darting about in numbers, and I learn that the sewer-mouth was a favourite spot for anglers.

Among amphibious animals frogs are found in pure waters, or in those but slightly polluted, and the same may be said of newts. If either excrementitious or manufacturing refuse is introduced in appreciable quantities they withdraw.

The presence of aquatic insects is not a character from which any definite conclusion can be drawn. When manufacturing refuse has been largely introduced they are generally absent. Thus, I have never seen either larvæ or adult insects in the Bridgewater Canal or the Irwell below Manchester, in the notorious Sankey Brook, in the Ayre below Leeds, the Kelvin Water, and similarly polluted streams. But in rivers largely fouled with putrescent vegetable refuse or fœcal matter they abound. On the other hand, in the very purest water they are necessarily absent as finding there no food. It would be interesting to find what is the minimum of impurity at which the larvæ of gnats and blood-worms (*Cheironomus plumosus*) are able to exist, and what is, if any, their maximum limit.

They are frequently found in water-butts and cisterns which have no other source of contamination but the organic matter suspended in the air. Still I should suggest that no water in which these larvæ are present should ever be used for domestic purposes, since their excretions, as far as I have been able to observe, set up in organic matter decomposition of an offensive and probably dangerous type. The character of their juices may possibly explain the irritating, and in some cases even dangerous, effects of the bites of gnats, mosquitoes, and pollution-fed Diptera in general.

Water-beetles, such as *Acilius sulcatus*, *Colymbetes sp.*, &c., and also certain Hemiptera, may be found in water which, from the absence of known sources of pollution and from chemical and microscopical examination, may be pronounced

potable. But they are also met with in pools fed by the surface drainage of manured fields and pasture lands. As a rule it may be said that animals which prey upon living animals or growing vegetables are not, in themselves, a bad symptom. All such as consume dead, comminuted, or putrescent matter, whether animal or vegetable, must be considered highly objectionable, as proving the presence of the bodies upon which they feed.

We may, therefore, probably conclude that neither vegetable nor animal life varies in any single relation with the proportion of oxygen found in a stream; that sewage fungus and all aquatic growths devoid of chlorophyll, where existing alone, indicate great pollution; but that where they occur along with green plants the impurities may be very trifling. Yet even vegetation of a relatively high grade, such as the water-cress, gives no positive proof that a stream is wholesome and potable. Lastly, it is impossible to argue from ordinary town-sewage to manufacturing-refuse, or to a mixture of the two. The influence of the former upon animal and vegetable life is widely distinct from that of the latter.

IV. THE INCONCEIVABLE AS A TEST OF TRUTH.

By F. H. Nash.

THAT all our knowledge is subjective is now looked on by a large number of those who think on such matters as a proposition proved. That this is equivalent to saying that knowledge in the true sense of the word is not to be attained by us at all, is at least to "our present reason" evident. That the same proposition logically involves general scepticism is not, however, my reason for calling it or its alleged proofs in question. If it be true let it stand. "*Fiat justitia ruat cœlum.*" Locke was no sceptic, yet his system, which referred all our ideas to experience, necessarily led to scepticism. Kant did not love scepticism, he desired to set up a barrier against it; yet he is supposed to have completely established the doctrine of the subjectivity of our knowledge, and may therefore be considered the father of such modern scepticism as deserves the name of

philosophy at all. Kant saw that Locke had totally failed, as all men must fail, in the attempt to trace all our ideas to experience. He admitted the existence of *a priori* ideas or principles of mind, independent of all experience. The admission of one such idea, on principle, is of course the annihilation of the empiric system. Kant taught that the phenomena of experience, meeting their *a priori* principles (which might as well be called innate), formed our knowledge, which was, therefore, the joint production of the Ego and the Non-Ego. Locke had compared the mind before experience to a sheet of blank paper. According to Kant's view it might be compared to the glass of the photographer, on which the picture is the joint work of the sun's rays and the preparation of silver. It may be worth observing that in this last case the outlines are true to external objects, while the colouring is false. Now whatever title we may give to these *a priori* ideas—primary, innate, connate, or necessary—the acknowledgment of their existence is fatal to the theory that all our knowledge is based on experience. Kant acknowledged their existence, and thus opened at least a chink through which Descartes might peep and see how much had been really added to mental science since his time.

But if our knowledge be not wholly founded on experience it may still (if it deserves the name) be founded on experience and our nature, and so be truly subjective. Whether it is so is the question before us. If we can know anything with the certainty that it ever was and ever must be true, irrespective of our existence or the actual existence of any given beings, then so much of our knowledge, be it never so little, is necessary truth—not subjective, but objective. If, on the other hand, there be no truth so certain but that, in a new sphere, or with new enlightenment, we might find it to have been an illusion, then all that we have by way of knowledge is subjective and possibly illusory. It cannot be called subjective because it is *in* us unless it also appear that it is *of* us. Are there then any Necessary Truths? Dr. Whewell's definition of necessary truths will suffice for my purpose. "Necessary truths are those in which we not only learn that the proposition is true, but see that it *must* be true, in which the negative is not only false but impossible, in which we cannot, even by an effort of imagination, or in a supposition, *conceive* the reverse of what is asserted." Here, *the inconceivable* is clearly admitted to be the test of the presence of a necessary truth, independent of ourselves. If then there be any proposition the contradictory of which is inconceivable, that proposition is true, and as part of our

knowledge is not subjective but objective. Although in us, it is not of us, but belongs to the eternal nature of things. It is not the Ego nor a part of the Ego. It has come to it, and it has not come from experience. It is as objective to the human mind as anything could be supposed to be to any other thing. But are there any such truths? And what is *the inconceivable?* It appears to me that this term has been used with wonderful negligence, even by most distinguished writers. Mr. Mill says that "inconceivableness has very little to do with the possibility or impossibility of anything in itself, but is a matter of accident and of the past history and habits of mind." Even Whewell abandons his own definition, and speaks of the existence of Antipodes and the Copernican system having been at one time "inconceivable." Spencer connects it with the result of human experience, and that leads us to the detection of the abuse of the word which renders it now *utterly useless* in philosophy, viz., the *confusion,* as I venture to call it, between the "conceivable" and the "believable." In like manner, Hamilton, in order to show that the "inconceivable" may sometimes be true, adduces this *dilemma*—"Either matter is infinitely divisible, or there is a limit to its divisibility, but we cannot conceive either." We certainly cannot realise either, or picture it to ourselves, or make it a clear object of contemplation. But this is not the sense of the word *conceive,* in which it can be of any use in philosophy, because in this sense, the conceivable is undoubtedly subject to accidental circumstances, and must be different in different men. But when the word is taken in its true sense, the case is quite different. Hamilton admits that there are two propositions absolutely true, quite independent of us, viz., that two contradictory propositions cannot at once be true, or at once be false. Although these certainly go but a little way toward enlightening us on the nature of things, yet they are of great value as supplying clear types of *the impossible.* That they are wholly independent of experience appears from this, that should a man be found to whom they were not self evident, the case would not for a moment be supposed an exception to a general consent, or a deviation from the "net result of experience," but simply as evidence sufficient of the absence of suspension of the reasoning power in that man. Such a man would of course be incapable of knowledge, and as to the conception of general ideas, would not differ from the brutes. Thus we obtain a very moderate test of the presence or absence of *reason.* This test will admit to the class of rational beings all men and women, educated or uneducated, civilized or

barbarous, who are completely human beings and not idiots. Idiots are persons incapable of perceiving that it is impossible that two contradictions should be either both true or both false: I take to be persons either without the faculty of reason or with the means of communication so deranged that we may imagine them to mean one thing when they seem to say or signify another, while we cannot determine that they conceive any idea at all. I would now define "the inconceivable" to be that which no one in possession of reason can entertain for a moment as possible, but must reject as repugnant to reason itself, as a contradiction which destroys itself, in which there is nothing to picture to the mind or to discuss "*vox et præterea nihil.*" If this be so, whatever was at any time inconceivable will be for ever so, and nothing that has ever been conceived was at any period or by any other persons inconceivable. What men could be persuaded to believe, or even to entertain as possible or probable, has always varied with the circumstance and will always vary; but before these questions of possibility, probability, or credibility can arise, the mind must first be able to *conceive* the proposition, that it does not in the expression destroy itself. It must stand before the mind as possible under some circumstances, even if it is to be condemned as impossible under the existing or supposed circumstances. The ancients, who are erroneously said to have been *unable to conceive* the existence of Antipodes, because they refused to believe it, had their attention been drawn to some flies walking on the ceiling, just as others walked upon the table, would have replied that men were not like flies, a direct appeal to experience. They conceived the proposition, but they rejected it on account of certain objections. The same is true of other ordinary illustrations of the "inconceivable." But we have here the means of giving a clear definition of it, and thus restoring the term to usefulness. The man who can comprehend the general proposition, that of two contradictions both cannot possibly be true, nor both false, anywhere or in any state of being, is possessed of reason. The man who cannot comprehend this as a general proposition is destitute of reason. "The inconceivable" is that which every man possessed of reason is *ipso facto* compelled to reject as incapable of being presented to the mind as a supposition, as involving the negation of that understanding which was to consider it as in fact self destructive. It is on this ground, and on this ground *only*, that Sir W. Hamilton can affirm his two proposition, that their contradictories are to this exact extent *absurd*. To say,

therefore, that these propositions are certain, and that we have no other certain knowledge, is to say that there is no other proposition for which we would claim certainty, of which the contradictory is not *conceivable* in the sense which I have proposed for that term. All those, therefore, who assert that we have not the like certainty of any other proposition, are bound, if any proposition is offered to them as of equal certainty, to be prepared to say that they can and do conceive the contradictory of that proposition as possibly true in some other sphere and possibly apparent in another state of enlightenment. If reason absolutely refuses the possibility of the contradictory, it *ipso facto* affirms the independent and absolute truth of the proposition. To illustrate this, let the idea be that of a man reclining in a blast-furnace drinking melted marble; or of a temperature that would freeze the flame of a lamp, so that it should be gradually forced upward in the form of a pellucid cone; or of hydrogen stored in blocks to be split up for fuel, or of preserving the heat of the dog-days in casks to temper the severity of the winter. These ideas are quite opposed to experience, but there is no contradiction present. They are conceivable. Again, a region where the attraction of gravity was replaced by repulsion, so that houses had to be screwed into the ground, &c.; or where people were born in a state resembling old age, and after passing through maturity, youth, and childhood, *attained* to infancy and then died; or where a man could detach a diseased organ from his body and leave it with the physician for repair as he would his watch with the watchmaker. All these are ideas which experience does not aid us to realise, but reason stands neutral. There is no contradiction; they are not inconceivable, therefore not necessarily false; and a rational man is bound to say that such things *could be*. Any conviction that we may feel that they are not is only subjective, or, in plain English, matter of *opinion*. But let the suggestion be of a region where things and conditions of things begin to be, without *anything* making them begin to be; or where things can be conscious of thought without existing; or where a number of lines in one plane, intersecting at one point, can make angles exceeding in sum those made by the first two; or where there can be merit without intention, or guilt without free will; or where there may be limits to space and no space beyond those limits, that is to say, beyond those limits neither something nor nothing; or where there is no duration or succession, but all things are simultaneous; or where there is no number, but 1000 may be sometimes more,

sometimes less than 10, and a product of 62 may be obtained indifferently from the factors 6 and 2, 8 and 11, or 29 and 3. Those who would limit our absolute knowledge to the one single proposition (expressed by Hamilton in *two*, under the sounding names of contradiction and excluded middle),* "That which is, is" are bound to say that these last suggestions, to which many more might be added, *can be true*, that they involve no contradiction to *their* reason. Rational man, however, *knows* that they are absurd and self-destructive; that reason stamps them out of the nature of things, and consequently their contradictions are true if we had never existed; nay more, that if the universe itself, with its Author, could cease to exist, they would remain potentially true for ever. They would not be knowledge while there was no mind to know them. But should, *per impossibile*, a mind come into being, it would *find* them true, and that time and space had been waiting during the interregnum for landmarks and apportionment. It may be observed with regard to two of these propositions, that some maintain that our idea of merit and demerit is merely the result of a calculation of expediency which has become in some inexplained way a part of our nature. This is immaterial; it is sufficient that we have the ideas of *duty* and *interest*, as distinct from one another as that of either from that of a triangle. This is matter of universal conscience, and the theory has been so often rejected that no one is supposed really to believe it, but to repeat it only as harmonising with his system, or under the impression, strangely prevalent in these days, that by piling "it may be" upon "it may be," we are approaching the proposition that "it is."

With regard to the whole group of propositions which can be proved by the test of the inconceivable in this sense of the term, it would appear that the actual existence of but two beings can be so established, that of the thinking mind by consciousness, and that of God by causation. The number of general propositions which can be associated with this absolute certainty, and their bearing on other matters of belief, are topics on which of course I cannot enter here. I conclude by stating in a few words the position that I have meant to establish. If it be (as is admitted) absolutely true, independent of experience or any thinking mind, that of the propositions all A is B, and some A is not B, one must be

* Mr. Mill endeavours to make it appear that there is a third alternative when the proposition is "unmeaning," the predicate not being in itself predicable of the subject—as "Constitutional Government is blue;" but if it be not predicable, the *negative* is obviously true, if there be a meaning in the words at all.

true and the other false; this is certain only because the opposite of it, that both may be true or both false, is submission of reason itself. Hence it follows that if of any other pair of contradictories one be equally subversive of reason itself, that is to say if it be "inconceivable," then the other is *true*, independent of all experience, or of any thinking mind; to which mind it is wholly external and objective. I think that I have shown that such propositions there are, and that a certain amount of objective knowledge is ours, even in the present existence; that we are not tossing adrift in a chaos of illusory forms, but that while our view of surrounding objects in general is undoubtedly modified by the medium through which we perceive them, *our feet nevertheless stand on a rock, narrow it is true, but immovable.*

V. EXPERIMENTS WITH THE "JUMPERS" OF MAINE.*

By George M. Beard, M.D.

(Concluded from p. 93.)

BEFORE I visited Moosehead Lake, while I knew only those facts that were obtained at second or third hand, I felt quite sure that this disease would be likely to be a family inheritance. This deductive reasoning was confirmed by inductive observation. It is fully as hereditary as insanity, or epilepsy, or hay-fever, although it has no special relation to any of those forms of disease. In the family of one of those with whom I experimented there were five Jumpers, the father, two sons, and two grandchildren of the respective ages of four and seven years. In the family of another with whom I experimented there were four, all brothers. In the family of another of whom I obtained information, but did not study, there were three cases, an uncle, a mother, and a brother. In another family there were two boys, both Jumpers. Here, then, were fourteen cases in four families. By the study of these cases it was possible to trace the malady back at least half a century.

Endemic and Contagious.—Jumping seems to be endemic, confined mainly to the north woods of Maine and to those of French descent, and is psycho-contagious—that is, can be caught by personal contact, like chorea and hysteria.

Shortly after I began these researches, I found in a copy of the London "Medical Record" brief reference to precisely similar phenomena on the other side of the globe, among the Malays. The notice was very brief indeed, but it was sufficient to show that there was no difference in the phenomena as exhibited in these different races. I have been told that in northern Michigan these Jumpers are to be found, but have obtained no evidence on that point that is entirely satisfactory. It would not be improbable that this assertion should be proved to be true, since the class among whom Jumpers are found is somewhat migratory, although not so much so as the English and Americans.

Origin and Philosophy of the Disease.—Jumping is probably an evolution of *tickling*. Some, if not all, of the Jumpers, are ticklish—exceedingly so—and are easily irritated by touching them in sensitive parts of the body. It would appear that in the evenings, in the woods, after the day's toil, in lieu of most other sources of amusement, the lumbermen have teased each other, by tickling and playing, and startling timid ones, until there has developed this jumping, which, by mental contagion, and by practice, and by inheritance, has ripened into the full stage of the malady as it appears at the present hour. This theory is in harmony with the general facts of physiology, and explains, better than any suggestion that has occurred to me, the history of what would otherwise appear to be without explanation, and almost outside of science. In a certain sense, we are all Jumpers; under sudden excitement, as of a blow, or a violent, unexpected sound, any person, even not very nervous, may jump and cry, somewhat as these Jumpers do, though not with all the manifestations of the Jumpers. Hysterical women, jumping and shrieking on slight excitement, we have all seen.

Everything about this subject is incredible. I do not expect that my readers will believe all, if they believe any, of what is here reported; rather they will find it easier to believe that I have been deceived; that the six sources of error that are involved in all experiments with human beings, were not fully eliminated; that the Jumpers, in short, experimented with me, and not I with the Jumpers; and that through all of this half century, the guides and physicians, the proprietors of hotels, and their neighbours, and relatives, and friends, have been the victims of intentional or unintentional fraud. But to my own mind the most incredible fact of all is, not the existence of the phenomena, but that the phenomena have not been sooner observed by science, and

that they have so long escaped the notice even of scientific men who live near or in those regions, and who frequently visit them.

Two of the best known citizens of Greenville—a town at the foot of Moosehead Lake—who have lived there very many years, if not all their lives, who have had these Jumpers in their employ, denied or doubted the existence of any of these phenomena, declaring that these so-called Jumpers were merely drunk or playing. My guide in the woods of northern New Hampshire, who had spent his whole life in those wilds, who was old enough to be a great-grandfather, denied, without reservation, the whole claim; but, after investigating the subject with me, was compelled to admit its genuineness. One of my fishing companions in the woods, a clear-brained and vigorous man of business, and a man of the world, who, for seventeen years had passed his summers in these regions, knew nothing of the subject until this season when I called his attention to it. All around these districts there are physicians, not in them but near them—for in the summer season the umpers scatter, to a certain degree, over the farms in the vicinity—and every year physicians and men of science, experts in various realms, visit for recreation the districts where these Jumpers most abound; but if they see them they do not notice them, or if they notice them they do not understand them, or if they understand them they say nothing about them, and do not attempt to bring, or at least do not succeed in bringing, the phenomena into science.

ANALYSES OF BOOKS.

*Vivisection, its Opponents and Richard Wagner.** By Wilhelm Jensen. Stuttgart: Levy and Müller.

This little work opens with a humorous but faithful account of the rise of the present most lamentable agitation. The author remarks that in all times cases have occurred when the great conflict between Reason and Folly suddenly concentrated itself in some region which had hitherto remained in peace. Such, till lately, was the position of Physiology, pursuing quietly her course, whilst the merits of her labours were hidden behind those of the medical practitioner, who applied her results to the service of mankind. But few years ago the layman who should have presumed to prescribe to physiologists what methods of research should be adopted, and what should be avoided, would have been generally, and justly, pronouuced insane. Suddenly there has broken out, especially among nations of Germanic descent, a mental epidemic which reminds us, *e.g.*, of the dancing mania in the Middle Ages.

Physiology has been accused and condemned in the same breath in a manner which in mendacity, stupidity, and effect among the ignorant equals the agitation concerning the Marpinger miracle. Profs. Heidenhain, Herrmann, and Virchow have indeed put forth pamphlets in defence of the liberty of research, but the majority of physiologists have thought it beneath them to defend their cause in non-scientific organs. Such conduct, however, at least as far as England is concerned, is a serious error. A vast majority of the public never read scientific journals; they meet consequently with no exposures of the misrepresentations circulated in literary and political organs by professional agitators and anile sentimentalists, and thus we are in danger of being overpowered by organised ignorance.

Our author proceeds to give a definition of vivisection which is logically correct, but differs greatly from that adopted by our essentially illogical sentimentalists and law-makers. In their eyes every "painful experiment"—or rather every experiment which they pronounce painful—is vivisection, even though no "section" at all should take place. Thus the British toxicolgist is deprived of the use of an occasionally useful method of recognising poisons. He may not, *e.g.*, administer to a rabbit or a Guinea-pig an extract obtained from the contents of the viscera of a person supposed to have been poisoned, in order to

* Ueber die Vivisektion, ihre Gegner und Herrn Richard Wagner.

conclude from the symptoms produced the nature of the substance administered. Here lies one of the grossest errors of the anti-vivisectionists ; they declaim against the barbarity of " cutting animals up alive," and then include under this category operations such as those involved in the researches of Pasteur !

Herr Jensen raises two questions :—Has man the right to dispose of the life of animals for his advantage ? and, if this be conceded, is the benefit derived from vivisection so great that the apparent cruelty of physiologists becomes in reality benevolence ? The first point, man's right over the lower animals, he considers cannot be proved, but that it can be legitimately called in question only by that very rare being the consistent vegetarian, who renounces milk " because it cannot be obtained without keeping the cow in an unnatural condition, who allows himself to be bitten by a mad dog rather than knock out its brains, who looks on calmly while his goods and chattels are gnawed by mice and rats, who regards bug- and gnat-bites as justifiable peculiarities of our earth's existence, and who does not blame the cook if she serves up fragments of cockroaches in his coffee." Such a man, and such only, can logically and consistently denounce vivisection ! It is edifying to think that if we " move on " in the direction we have now for a few years selected, such men will form a powerful interest in the State, and may even rule over us. Fanatics of all grades are ever ready to join hands against rational men. If the anti-vivisectionist reply that he objects not so much to the rapid death of animals for man's convenience as to their prolonged existence in a state of mutilation and pain, the author is ready with an overwhelming answer. Throughout Europe there are millions of animals which are mutilated for the good of their possessors by means of a painful operation, and which for the rest of their lives remain mere shadows of their natural selves. Our humanitarians might further see sheep newly-shorn and trembling with cold ; pigs, capons, and geese crammed to immobility and suffocation. All this torture is inflicted upon millions of unoffending animals for the convenience of man. Yet no benevolent society is formed to combat the " horrible sin," either by sensational pamphlets or by stirring up the mob to deeds of violence !

The author then proceeds to show that the benefits of vivisection for the present and the future race of mankind, for the development of science and of practical medicine, are so great that the sacrifice of a few animals must be regarded as, in comparison, utterly insignificant. He reaches the legitimate conclusion that they who seek to obstruct the progress of science with slanderous accusations must belong to one out of two contemptible classes of beings.

Passing from defence to attack, Herr Jensen traces the origin of the anti-vivisection outcry among the aristocracy and clergy of England. He argues that the latter opposed vaccination and

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ever the hybridisation of plants, and that, in seeking to check the progress of biological research, they are fighting against their most dreaded enemies—the inquirers into the bodily and spiritual vital conditions of man. We fear that the author here forgets how "free thought" has, in the person of one at least of its champions, joined the motley army of anti-vivisectionists. He then passes on to show the gross inconsistency of the aristocratic and sporting opponents of physiological research. He paints in glowing colours the holy alliance between Exeter Hall and Hurlingham. Though some of his charges against the pursuits of our country gentlemen relate rather to the past than the present, it must be admitted that one of their old sins—cock-fighting to wit—has lately experienced a revival. From England the "germs" of the agitation were carried over to Germany, and found an apt nidus in a certain Ernst von Weber, a "knight of high orders, possessor of the Imperial Austrian medal for Art and Science, member of the council of the Dresden Society for the Protection of Animals," and author of "The Torture-Chambers of Science"—a pamphlet admirably adapted to the comprehension of the class of people which at Leipzig burst into and demolished the Physiological Institute! The writings and speeches of this man have met with more acceptance than might have been hoped in Germany. But even in that country the entire population does not consist of enlightened thinkers. It is very much to be regretted that among the dishonourable means employed by the anti-vivisectionists has been a species of forgery. Thus Sir Charles Bell, Darwin, and Rockitansky are alleged to have declared vivisection useless for Science. The author shows the untruthfulness of these statements, and quotes textually a document signed by Charles Darwin, and dated 1876, addressed to the Leipzig Physiological Society.

The statement that both in England and Germany "practical physicians" have pronounced vivisection unnecessary is severely but truthfully encountered. The very same kind of practitioners—routine prescribers and fee-takers—reject the application of physical, chemical, and microscopic research to the art of healing, and in fact dispense with physiology altogether. There are a certain class of medical men who, having spent the best part of their college years in the tavern and the fencing-school, by some marvellous turn of luck slip through the "State examination," and are duly authorised to angle for patients. How are such men to earn a livelihood in an over-crowded profession where even great merit may not be recognised until too late? The choice lies for them between hunger and quackery, and we need not say which alternative they select. They become homœopaths, hydropaths, anti-vaccinationists, anti-vivisectionists, or anything which may flatter the ignorance and the prejudices of the public. Such are the greatest part of the medical practitioners who for the sake of popularity are willing to compromise the advance of Science.

As for Richard Wagner, he proves to be the opera-composer of Bayreuth—a man utterly unqualified to decide on such a subject, and really not worth half the notice which Herr Jensen bestows upon him.

The work before us deserves, as a whole, the approval of all friends of Science. We wish that some publication of a similar kind, adapted of course to the different state of circumstances in England, could be widely circulated in our country, in order to open the eyes of the public.

Peruvian Bark. A Popular Account of the Introduction of Chinchona Cultivation into British India. By Clements R. Markham, C.B., F.R.S. London: John Murray.

It will be difficult for any Englishman to read this narrative without mingled feelings of triumph and regret, even of humiliation. We see, on the one hand, a great and noble national enterprise, worthier far than was ever sung by epic poet of old, carried to a successful conclusion. We read the history, as it were, of a victorious campaign waged against fever, and of an increase in the material resources of one of the most important sections of the British empire. Yet, on the other hand, we learn the sufferings and the neglect which have been the reward of the devoted band by whom such splendid results have been achieved.

The general public is, of course, aware that the various species of trees of the Chinchona family are of exceeding value to the human race as being the source of quinine, now one of the most indispensable requisites of the physician. These trees are naturally found on the eastern slopes of the Andes, from the Bolivian province of Cochacamba in 19° S. into Colombia, a distance of 1500 miles. For more than two centuries the whole supply of Peruvian bark had been drawn from these forest regions, without any attempt at systematic cultivation. The wandering *Cascarilleros* stripped the bark from the trees, and left them to perish. Such a system persistently followed could have but one result, even in the luxuriant climate of South America, and as the demand for quinine has been on the increase over the whole world it became evident that the price of this invaluable remedy must soon rise so high as to put it out of the reach of all but the wealthy. It was therefore resolved to attempt the introduction of the Chinchona trees into India. By this step it was hoped that the supply of quinine and its kindred alkaloids would be greatly increased, the price kept within reasonable bounds, and the people of India would be supplied at an easy rate with a

medicine without which even the natives find the maintenance of health difficult in certain districts. All these hopes, we may say, have been fully realised.

On the other hand, the difficulties to be encountered were most serious: young seedling trees had to be sought and dug up in the midst of trackless and often pestilential forest regions, and conveyed for hundreds of miles to a sea-port for embarkation. The jealous and ignorant natives looked upon the enterprise with decided hostility, and the tree-hunters were in considerable danger. One Manuel Marten threatened to stir up the people to seize them and cut off their feet! The young trees had next to be placed in Wardian cases for embarkation, and conveyed to their destiny. Mismanagement in high quarters was not wanting. It might naturally have been expected that our Government would have had vessels ready to convey the precious plants directly across the Pacific to India. This rational step was not taken. H.M. steamer *Vixen* was allowed to be idle at Islay whilst the plants were shipped for Panama, conveyed across the isthmus, shipped again for England, and despatched thence to India *via* the Red Sea, being thus exposed to the greatest possible vicissitudes of climate. On reaching India the difficulties were far from being at an end. It was necessary to select localities for the intended plantations resembling their native regions as closely as possible in latitude, altitude, temperature, rainfall, soil, &c. With care and patience the task was accomplished, and the result may be summed up by saying that every valuable species of Chinchona known in South America has been introduced into India.

The original object was to bring a cheap febrifuge within the reach of the mass of the people. This has not merely been effected, but the enterprise has proved a most profitable public work. The sums expended have been repaid with interest, a large annual profit to the State has been realised, a valuable product has been established in India and Ceylon, and a new and important supply of bark for the European market has been created. India now stands second in quantity among the bark-exporting regions of the globe, and in quality it is the most important of all. Samples from the Nilgin plantations have fetched 15s. 8d. per lb., the highest price ever obtained.

It must never be forgotten that this brilliant success, like most British triumphs either in peace or war, has been earned not by the forethought or the organising capacity of Government, but by the energy, the tact, and the devotion of individuals. How have these individuals been rewarded?

Among the most active of Mr. Markham's coadjutors was the eminent botanist Dr. Spruce, to whom fell the task of collecting the plants and seeds of the "*succirubra*" species, which now yields an annual income of many thousands. He returned to England in 1864, an invalid for life, and incapacitated from fol-

lowing his profession. In 1865 he received, after earnest appeals to Government, a pension of £50 a year from the Home Government, and in 1877 a further sum of £50 a year was added by the Indian Government.

Mr. Cross, the introducer of *C. officinalis*, made six expeditions, encountered great dangers, and suffered repeatedly from fever. The sums he has received have barely covered his expenses out of pocket. On his final return to England, in 1879, he received two sums of £300 each for about nineteen years' service.

Mr. John Weir, the gardener, was a most important element in the success of the undertaking. Without his skill and knowledge it is very doubtful whether the young plants would have been shipped in a healthy condition. In 1865 he was brought back to England a cripple for life, and had no resources save the interest of £600 collected for him by the Fellows of the Horticultural Society, and his wife's earnings. Mr. Markham's urgent appeal for a small grant in recognition of Weir's excellent services was refused. What statesmen or what administrations are responsible for such injustice we do not care to ask; but we cannot hear without shame and indignation of such treatment being meted out to men who have deserved so well of their country.

Mr. Markham's work is full of interesting observations, botanical and climatological, both respecting South America and India, and will be read with delight by all lovers of adventure and enterprise.

The Journal of Speculative Philosophy. Vol. XIV., No. 3. New York: D. Appleton and Co.

In this number our attention is especially called to a highly original article by Mr. Payton Spence, entitled "Atomic Collision and Non-Collision, or the Conscious and the Unconscious States of Matter; a New Theory of Consciousness." The author shows, in the beginning of his memoir, that consciousness seems to stand abruptly apart from the world of matter and its phenomena; that it "has hitherto no scientific genessis." He thinks that matter exists in two states, a negative and a positive, the latter being induced by the collision of atoms, and varying indefinitely in degree. Here, then, we have the "conscious and the unconscious universe—the negative being the unconscious, and the positive the conscious." He uses the term conscious in a wider sense than is usual, embracing under it "not only human and animal consciousness, as is generally done, but also in-

cluding all degrees below that of human and animal consciousness, as well as all degrees above it." He holds, therefore, that mind runs deeper down into matter than is generally supposed. Having identified force with consciousness, he asks if we have still an irreconcilable duality? In reply he maintains that consciousness is an ultimate fact which cannot be surrendered,—that matter is that something whose modifications are states of consciousness. "In the act of atomic collision matter and consciousness, the thing modified and its modification, are causally and efficiently related. Hence matter and consciousness are in their ultimates the same, and consciousness is the ultimate, unitary cosmic constituent.

We regret that space does not enable us to develop the author's argument at length.

John Hopkins University, Baltimore. Studies from the Biological Laboratory. "The Development of the Oyster," by W. K. Brooks, Associate in Biology. No. IV. Baltimore: J. Murphy and Co.

We have here a very valuable monograph. The author finds, in the first place, that, as regards the American oyster of the Chesapeake Bay, the ova are fertilised not within, but without, the body of the parent—an important difference from the European species. After describing the general anatomical characters of the species, he passes to an account of his experiments on the artificial fecundation of the ova. In connection with this subject he finds that the American oyster, like its European congener, is not a hermaphrodite; but he states that there is some reason for the belief that an oyster may produce eggs one season and sperm-cells the next.

The author has very carefully studied the development of the young brood, and it is to be especially noted that he finds them pass through a distinctly-marked "gastrula" stage. Mr. Brooks has unfortunately failed in tracing the process by which the swimming embryo becomes converted into the sedentary adult. The chance of a young oyster reaching maturity has been calculated by Möbius at 1 in 1,145,000.

The author remarks that the general occurrence of a gastrula stage in so many widely separated animals is certainly the most pronounced feature in embryology, and it is possible that a more complete acquaintance with the development and the phylogeny of the Mollusca may show that the facts held do not in reality oppose the view that it is an ancestral form. But our knowledge of facts, he adds, must be very much greater before we are

qualified to lay down any general hypothesis on the ancestry of the Metazoa.

A separate memoir is devoted to the acquisition and loss of a food-yolk in Molluscan eggs.

The English Universities and John Bunyan, and the "Encyclopædia Britannica" and the Gipsies. By JAMES SIMSON. New York: James Miller. Edinburgh: Maclachlan and Stewart. London: Baillière, Tindall, and Co.

THE title of this little work seems to require some explanation. The author maintains that John Bunyan was a Gipsy, or at least of Gipsy origin,—a question possibly of interest to the literary world, but which does not in any way fall within our jurisdiction,—and he appeals to the Universities of England, and to all connected or who have been connected with them, to discuss this point. Mr. Simson then criticises an article on Gipsies in the "Encyclopædia Britannica," from the pen of Mr. F. H. Groome. A passage which the author quotes from Lord Macaulay should not be passed over without solemn protest. Says the great Whig historian:—"Though there were many clever men in England during the latter half of the seventeenth century, there were only two great creative minds. One of these minds produced the 'Paradise Lost,' the other the 'Pilgrim's Progress.'" The writer here very characteristically ignores a mind which produced the "Principia"—of far greater value than the "Paradise Lost" and the "Pilgrim's Progress" put together.

The ethnological questions involved are from our point of view much more important. To us it seems unreasonable to expect social equality for a strange race which has obtruded itself uninvited into European countries, so long as it refuses to become merged in the great body of the people. A distinct caste, if not a dominant aristocracy, must take the rank of Pariahs. To an absorption of the Gipsies we can see no objection.

Popular Lectures on Scientific Subjects. By H. HELMHOLTZ, Professor of Physics in the University of Berlin. Translated by E. ATKINSON, Ph.D., F.C.S. Second Series. London: Longmans and Co.

THE subjects of the Lectures contained in this series are—"In Memory of Gustav Magnus," on the "Origin and Significance of Geometrical Axioms," on the "Relation of Optics to

Painting," on the "Origin of the Planetary System," on "Thought in Medicine," and on "Academic Freedom in German Universities." Not many living men would venture to discourse before learned and critical audiences on so wide a range of topics, and no one probably would acquit himself so satisfactorily. But whilst we recognise the full value of the teachings of Prof. Helmholtz, we cannot but pronounce him a dangerous example for the student. The versatility which he exhibits is not shared by one mind in a million.

Prof. Magnus may be regarded as having done for physics what Liebig did for chemistry. The modern physical laboratory arranged for experimental instruction in optics, heat, electricity, magnetism, is his creation. His collection of apparatus, which on his death he bequeathed to the University of Berlin, is a silent but emphatic testimony to his character. Every instrument is not merely the best procurable, but every requisite which may be wanted in the course of experimentation is sure to be close at hand. As a teacher he constantly urged upon his pupils the appeal to observation and experiment. He did not recognise the absolute distinction formerly admitted between the organic and the inorganic world, but, as Prof. Helmholtz says, "in his research on the gases of the blood (1837) he dealt a blow at the heart of vitalistic theories." He is described as having led an especially happy life in the centre of an affectionate family, and in a circle of faithful and distinguished friends, whilst his circumstances allowed him to devote his whole time to successful research.

In the lecture on the relation of Optics to Painting we find mention of a remarkable fact: the brightest colours of a painter are only about one hundred times as bright as his darkest shades. The brightest white on a picture when most brilliantly illuminated has probably one-twentieth of the brightness of white directly lighted up by the sun. On the other hand, white garments in moonlight or marble surfaces will always be from ten to twenty times as bright in a picture as in reality.

In the concluding portion of the lecture on the origin of the Planetary System, Prof. Helmholtz speculates on the possible extinction of organic life upon our earth. He seems to think it probable that animal forms may be developed capable of existing amidst the decreasing heat and light which must be expected in the remote future. He entertains the suggestion that meteoric stones may scatter germs of life in new worlds—a view which has involved him and Sir W. Thomson in a controversy with Prof. Zöllner. But we do not see that this hypothesis serves in the least to explain the origin of life. We have still the alternative, creation or spontaneous generation. If the latter is impossible in our world, why should it take place elsewhere?

As regards individual consciousness the author says—"As yet we know of no fact which can be established by scientific ob-

servation which would show that the finer and more complex forms of vital motion could exist otherwise than in the dense material of organic life. True; we cannot demonstrate or even conceive of an organised gas or organised ether, and yet he adduces certain analogies which may point to a different conclusion. He says, "The observer with a deaf ear only recognises the vibration of sound as long as it is visible and may be felt, bound up with heavy matter. Are our senses, in reference to life, like the deaf ear in this respect?

The lecture on "Thought in Medicine" gives some striking instances of the amusing arrogance of metaphysicians. "Schopenhauer calls himself a Mont Blanc by the side of a mole-heap when he compares himself with a natural philosopher."

It must be remembered that Prof. Helmholtz distinguishes between metaphysics and philosophy. He lays down the principle that a "metaphysical conclusion is either a false conclusion or a concealed experimental conclusion."

The discourse on "Academic Freedom in German Universities" is not laid before the reader in its original state. With the consent of the author, the translator has omitted some passages and modified others which he considers would convey an erroneous impression of the state of things as now existing in Oxford or Cambridge. It may still, however, be questioned whether the alterations in the English Universities approximate them tangibly to the German system. If Science is taught, it is taught as something to be examined in, not to make discoveries in. Of no English University can it be said, as Prof. Helmholtz truly says concerning those of his country, "Scholars speaking the most difficult languages crowd towards them, even from the farthest parts of the earth."

The author remarks that in college lectures, both in England and France, greater weight is laid upon eloquence than in Germany. It seems to us that our national worship of rhetoric, and the extent to which we are swayed by it, is a grave element of weakness.

There are few persons who cannot reap benefit and instruction from the work which we have thus briefly endeavoured to sketch.

Tables for the Analysis of a Simple Salt, for Use in School Laboratories. By A. VINTER, M.A. London: Longmans and Co.

"THE cry is still they come!" We have often groaned in spirit over the fertility of the English press in elementary works on chemistry, and wondered how long professors and teachers will go on trying to give us old facts and doctrines with a new face.

Germany has far more chemical schools than England. The number of her professors and teachers is greater; yet it is doubtful if she produces a tithe of our number of manuals. How is this? Are such works a by-product of the examination system?

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*History of Plastic Art from the most Ancient Times down to the Present.** Third Edition, enlarged and revised. Vol. I. Illustrated with 277 Wood-engravings. By WILHELM LÜBKE. Leipzig: E. A. Seemann.

WE have here the first volume of a very thorough-going and elaborate history of plastic art in the widest sense of the words. The author gives, in the first place, a brief survey of art in India, Egypt, the empires of the Euphrates, Asia Minor, Syria, and Cyprus. His main attention is of course given to classic art, which he traces from its origin to the overthrow of the Roman empire. Not merely the statues and architectural decorations are described according to their characters, but the coins, medals, gems, and other art-work in metals, ivory, &c., are treated in an appreciative manner.

The last section of the volume is devoted to the Byzantine and Mediæval art down to the twelfth century. In noticing the rise of so-called Christian art, the author points out very clearly that the asceticism of the times amounted to a formal war against beauty alike in art and in nature. Indeed one of the great merits of Herr Lübke's work is that he treats of the successive phases of art not as mere isolated phenomena, but as having their roots in the moral and social life of the times, and as instinct with the spirit of their civilisation. Consequently, while this work may be most profitably studied by the artist, and by those engaged in art-manufactures, it is also of high value for the historian, the philosopher, and the student of social science. The Ramses of Egypt, the Aphrodite of Gnidos, and the Virgin of Czenstochowa is each the exponent of its age and country.

An Examination of the Double-Star Measures of the Bedford Catalogue. By S. W. BURNHAM.

A REPRINT from the "Monthly Notices of the Royal Astronomical Society" (xl., No. 8). The author criticises the measure-

* Geschichte den Plastik von den eltesten Zeiten bis zur Gegenwart.

ments of Admiral Smyth, as given in the "Bedford Catalogue," and considers that Class II., *i.e.* double stars not previously measured by any other observer, are not perfectly satisfactory.

Transactions and Proceedings of the Royal Society of Victoria, Vol. XVI. Issued April 30, 1880. Melbourne: Mason, Firth, and M'Cutcheon.

This volume opens with the interesting Anniversary Address delivered by the President, R. L. J. Ellery, F.R.S., the Government astronomer. The author criticises the theory which connects the periods of sun-spots with commercial crises. He pays a well-deserved tribute to the merits of the Government botanist, Baron von Müller, with especial reference to his valuable memoirs on the "Forest Resources of Western Australia" and on "Select Industrial Plants." The President expresses a regret, in which we fully participate, that the biological and medical sciences are less cultivated in Australia than mathematics and physics. This is exactly what ought not to be: mathematical and physical research can be carried on as well, or better, in Europe; whilst biology, ethnology, geology, &c., present many questions which can be successfully attacked in Australia only.

Mr. Ellery has also contributed a memoir on the "Relation between Forest Lands and Climate in Victoria." He arrives at the important, and we believe sound, conclusion that "the indiscriminate clearing of timbered lands invites an ever-increasing aridity of climate and diminishing fertility of soil."

Mr. A. W. Howitt gives a paper on the diorites and granites of Swifts' Creek, and their contact-zones, with notes on their auriferous deposits.

Rev. J. E. Tenison-Woods, F.L.S., describes the genus *Amathia* of Lamouroux, and in particular a new species, *A. tortuosa*, and introduces a history of the progress of our knowledge of the Polyzoa.

The Rev. R. H. Codrington, M.A., contributes a paper on the customs of Mota, Banks Islands, many of which are fantastic in the extreme. It is remarkable that, though no monkeys occur in the Fiji Islands, yet the native language has a word for monkey. Through all these islands traditions of wild men, living in trees, are current. The author considers that the natives are not so wanting in moral feeling as is represented by Sir J. Lubbock, upon the authority of Mariner.

The remaining papers which we notice are—"New Localities for Minerals in Victoria," by J. Cosmo Newbery; "Notes on the Geology of the West Tamar District," by Norman Naylor; and

"On the Yarra Dialect and the Languages of Australia in connection with those of Portuguese Africa," by Hyde Clarke. The last-mentioned author considers that Australia was at some former period under the influence of a white race.

The Geological Magazine, or Monthly Journal of Geology. Edited by H. Woodward, F.R.S. October, 1880.

This issue contains an interesting paper by Thorvaldr Thoroddsen, on the volcanic eruptions and earthquakes of Iceland—a subject still very imperfectly known. The author enumerates the volcanoes known to have been active in historical times. Those still active form two lines, the one including Hekla, running from S.W. to N.E., and the other from S. to N. From A.D. 900 to the present day eighteen eruptions of Hekla are on record, thirteen of Katla, and many whose exact sources cannot be ascertained. Those occurring along Skapta and Hverfisfljot, in 1783, are pronounced of a magnitude unparalleled on the earth in historical times. They proved fatal to 9000 human beings, 21,000 cattle, 36,000 horses, and 233,000 sheep. From 1784 to 1821 no eruption is on record.

According to Mr. W. Pengelly the former presence of the glutton in Britain was demonstrated by the late Mr. J. C. Bellamy in 1839.

Journal of the Scottish Meteorological Society. New Series. LX. to LXIII. Edinburgh and London: W. Blackwood and Sons.

This issue contains a paper on the diurnal period of thunderstorms in Scotland, from which it appears that there is a well-marked daily minimum and maximum, storms being least frequent from 6 to 10 a.m., and most frequent from 3 to 6 p.m. There are traces of a secondary maximum from 3 to 6 a.m. In Iceland thunderstorms are essentially winter phenomena, and nocturnal.

A notice of the Tay Bridge storm of December 28th, 1879, mentions the extraordinary barometrical fluctuations near the central track of the storm. The temperature rose also to 51°—57°, being the average for the first week of June.

Victoria: Report of the Chief Inspector of Mines to the Honourable the Minister of Mines, for the year 1879. Melbourne: Ferres.

THIS report is devoted to the statistics of mining accidents and the means for their prevention. One man appears to have been poisoned by the fumes of burning nitro-glycerine.

Victoria; Reports of the Mining Surveyors and Registrars. Quarter ending March 31, 1880. Melbourne: Ferres.

THE total amount of gold obtained during the quarter is 179,949 ozs. 12 dwts., of which 66,174 ozs. 1 dwt. is from alluvial deposits, and 113,775 ozs. 11 dwts. from quartz reefs.

Records of the Geological Survey of India. Vol. XIII., Part 3. 1880.

THIS part contains an account of the Kumann Lakes, by Mr. W. Theobald, who maintains their glacial origin in opposition to Mr. Ball.

The same author communicates a notice of a celt of palæolithic type which he found near Shodipur, on the Indus. Kishen Singh, of the Geological Survey, had previously found a similar article near Rhotas, in the Punjab, but had thrown it away in ignorance of its nature.

Dr. Feistmantel furnishes palæontological notes from the coal-fields of Karharbari and South Rewah, and also notes on the correlation of the Gondwána flora with other floras.

Mr. W. King gives a note on the artesian wells of Pondicherri.

Mr. Hacket discusses the occurrence of salt in the soils and waters of Rajputana.

There are also some notices of an eruption of gas and mud on the coast of Arakan in 1843, and again in 1879.

Memoirs of the Geological Survey of India. Palæontologia Indica. Ser. XIII. Salt-range Fossils. By W. WAAGEN. Ph.D. Calcutta: Geological Survey Office. London: Trübner and Co.

THIS issue is devoted to the Gasteropoda, with a Supplement relating to fishes and cephalopods.

Monthly Notices of the Royal Astronomical Society. Vol. XL., No. 9.

This number contains a paper on Babylonian Astronomy, by Mr. Bosanquet and Prof. Sayce; an additional note by the Astronomer Royal on the Theoretical Value of the Acceleration of the Moon's Mean Motion; a paper by Mr. Glaisher, on the Method of Least Squares; and a memoir on the Possible Performance of an Object-Glass for Star-Gazing, by Mr. Sang. There is also a note on the Nebula near *Merope*, by Prof. Tempel; observations on Comet I, 1880, made at the Cape of Good Hope, by Mr. Gill; a method of determining the pressure on the Solar Surface, by Prof. Wiedemann; a note on a Disappearance of Jupiter's Satellites in 1611, and on the August Perseids, by Admiral Sir E. Ommanney.

The Attraction of Simple Gravity. By the Rev. G. T. Carruthers, Chaplain of Chakrata, India.

The author of this essay undertakes to show that Newton's theory of attraction is true merely as a result of a constant force in the line of motion. If his explanation is satisfactory, Newton's Law is removed from its eminence as a law of Nature, and occupies the ground of a convenient apparent law only. He considers that the true law of Nature is that of a force varying directly as the distance. "In the evaporation and condensation of water, which I assume to be the only motive force, we have two centres of force, one attracting and the other repelling with the same intensity, and so producing an apparent constant force." For the author's demonstration of these views we must refer our readers to his pamphlet.

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*The Lepidoptera of the Tauferer Valley.** By Prof. Josef Weiler. Insbruck: Wagner.

Like the determination of constants in chemistry and physics, the establishment of local faunæ is a tedious task, which, though of very high value to Science, is far from meeting with the recognition which it deserves. It seems to us that systematic

* Die Schmetterlinge des Tauferer Thales. Ein Beitrag zur Lepidopteren Kunde von Tirol.

observations of this kind are particularly needed along the great mountain chain which separates Central from Southern Europe as being calculated to show the respective adaptability of their northern and southern slopes to the life of different groups and the influence of the Pyrenees, Alps, Carpathians, &c., in obstructing or diverting the migrations of species. It is also calculated to throw light upon another point often overlooked as a condition of animal life—the influence of altitude. Swiss and South German naturalists recognise here six distinct regions: the plains and lower eminences up to 1800 feet (569 metres) above sea-level; the mountain dales with the lower forest-region up to about 1400 metres; the upper forest zone reaching to 1740 metres; the lower Alpine region up to 2000 metres; the lower Alpine to 2500 metres; and finally the snow-region including the mountain-summits.

The Tauferer valley does not extend down into the first region, and in consequence certain genera—such as *Apatura*—are absent, whilst others—such as *Papilio*, *Limenitis*, and *Satyrus*—are but slightly represented. The number of species and varieties actually captured or identified by the author and his friends amounts to—Rhopalocera, 134; Sphingidæ, 29; Bombycidæ, 80; Noctuidæ and Geometridæ, 166 each, making a total of 575 Micro-Lepidoptera. If from the 134 butterflies we deduct the 25 considered as mere varieties, there remain 109 true species. This is the more remarkable if we consider that many trees and shrubs upon which caterpillars feed are wanting, such as the oak, the beech, the snow-ball tree, the lilac, and the spindle-tree. The geological character of the district varies little, so that the great valley and its lateral dales afford no opportunity of studying the influence of such features upon the local occurrence of species. Still every dale has some peculiar feature in the forms which it presents. During the last thirty years the author has observed not a few changes in the Lepidopterous fauna of the district,—some of them referrible to the destruction of the forests and the recession of the glaciers. It does not appear to have formed any part of the author's plan to note whether specimens of any species found in this district vary in a uniform manner, whether in size and colouration, from their fellows in other Alpine valleys, or in the low grounds of Germany or Italy.

We must pronounce this pamphlet a useful contribution to entomology, and we wish that some of that unhappy class of collectors who waste their days in amassing so-called "British" species, and who give from £8 to £40 for a specimen merely because it has been caught in the United Kingdom, would spend their leisure in a similar manner to Prof. Weiler.

Natural Philosophy for General Readers and Young Persons. Translated and Edited from Ganot's "Cours Elementaire de Physique." By E. Atkinson, Ph. D., F.C.S. Fourth Edition. London: Longmans and Co.

A manual of physics like the present, free from mathematical formulæ and altogether couched in intelligible language, should command a wide circle of readers, and we are not surprised that the publishers have found it necessary to issue a fourth edition. The work contains not merely a clear, though necessarily concise, statement of the laws of optics, acoustics, heat, magnetism, electricity, &c., but it gives a description of many of the most popular applications of these sciences, the electric telegraph, the electric light, the telephone, &c.

We notice with some surprise, however, that in the chapter on light there is no mention of polarised light and its applications in physico-chemical research and in microscopy. Fluorescence also is omitted, and phosphorescence is briefly dealt with. The author remarks that this property is "very intense in the glow-worm and the lampyre." Glow-worm is the ordinary English name of the Lampyris. The figure of a compound microscope given is one of the old immovable upright type, the very sight of which makes our neck ache.

The paragraph on the liquefaction of gases can scarcely be considered on a level with the present state of science. Thus we read: "Few gases can resist these combined actions (cold and pressure), and probably those which have not yet been liquefied, hydrogen, oxygen, nitrogen, binoxide of nitrogen, and carbonic oxide, would become so if submitted to a sufficient degree of cold and pressure." These lines were of course written before the successful experiments of MM. Cailletet and Pictet, and have not been modified in accordance with the capital discovery effected by these eminent physicists.

We submit that in a work of such indisputable value as the one before us, these oversights should not have been suffered to remain.

Contributions to the Chemistry of Bast-Fibres. By E. J. Bevan and C. F. Cross. Manchester: Palmer and Howe.

In this memoir, which was read before the Owens College Chemical Society, April 16, 1880, the authors give the result of two year's work in a field of research which has hitherto been little cultivated. They take jute as the type of the class. The main portion of the intercellular tissue is, they consider, a cellulo-quinone. These investigations, which are still in progress, will doubtless throw new light on the principles of bleaching and dyeing.

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

LIFE AND MIND ON THE BASIS OF MODERN MEDICINE.

To the Editor of the Journal of Science.

Sir,—I have read with interest your criticisms of Dr. Lewins's "Life and Mind," and of my Appendix to that remarkable treatise. Will you allow me a small portion of your space in which I may answer, first, your allusion to Dr. Lewins's not venturing "to deny the possible existence of an Eternal Mind," or attempting "to show how physical energy is transformed into life;" and, secondly, your impeachment of my estimate of the character of those lives which are wholly devoted to scientific pursuits—"that is, to specialism."

A perusal of "Life and Mind" will show why its author refuses to dogmatise, or even to speculate, respecting the existence of a Supreme Intelligence. Such an abstention is the only possible logical result of the relativity of human knowledge which finds expression in Dr. Lewins's theorem that "higher than himself no man can think, his own perceptions and conceptions constituting his entire universe." If this position be self-evident it surely follows that either to affirm or to deny the existence of a something which utterly transcends man's perceptions and conceptions would be an act of gross inconsistency—altogether inconsonant with the first principles of his Thesis, as of Inductive Science itself. Any attempt to explain the transference of physical energy into life is now, ever has been, and probably ever will be, a purely eschatological abuse of reason—a Will-o'-the-Wisp pursuit of a phantom, which, as wholly beyond the range of our faculties, cannot be regarded as a rational theme for "explanation." There is as great a mystery underlying the different perfumes of the rose and the violet as that which veils the origin of life. Why these odours are different to our perception we do not know, and we are not called upon to explain. I may confidently state that the opinions I have expressed in my

Appendix, with regard to our duty of ignoring all things transcendental, are those of Dr. Lewins himself.

I will not encroach much further upon your space, except to say that, granting our postulate that healthy sensation is the chief end of Life, my allusion to modern specialists stand in no need of palliation. I submit that there have been, and are, men "who make discovery their ruling passion," and that to this Moloch "they sacrifice the harmony, equilibrium, and happiness of their lives." (*Vide* "Life and Mind," App., 59). The allusion to Faraday seems perfectly justified, since it furnishes an apt illustration of the evils resulting from the unnatural and uncalled-for protraction into old age of *intense* contemplative pursuits and analysis. I do not deny the value of scientific education, but I maintain that such should be confined to the formative (*Werdende*) period of human life. The "complete man" is he who preserves healthy sensation, whose cerebral functions have been duly trained, not over-trained, so as to become asymmetrical by excessive scientific discipline. In such a man we see, as Dr. Lewins expresses it, all that poets have fabled of the golden age, or that religious founders have denominated the kingdom of heaven. On the other hand, we know that outside his own speciality of formal Physics even such a prodigy as Newton was below, rather than above, the standard of the *Vir*—the all-round man, "*totus teres atque rotundus.*" Why, I would ask, does no very successful professional man desire for his son, or others dear to him, his own career?* If Science really were the supreme vocation its zealots represent it to be, how comes it we have not successive generations of scientists as we have of soldiers and sailors? In thus writing I know I express the experience of the author of "Life and Mind," who holds that in particular medicine presents no future for men of idea-ed minds, and that its routine drudgery only suits those among its followers who spring from the less cultured classes of the community. Its high rate of mortality alone proves its incompatibility with the conditions of natural life. If such be the case in the science of human nature, which medicine truly is, we can readily understand why, in modern Europe, scientists (*Fach-manner*) do not follow, in such matters, the obligatory, hereditary caste, or family system, as it obtained among the ancient Egyptians.—I am, &c.,

THE EDITOR OF "LIFE AND MIND."

* For in much wisdom is much grief; and he that increaseth knowledge increaseth sorrow.—*Ecclesiastes* i., 18.

A QUESTION OF CONSISTENCY.

To the Editor of the Journal of Science.

Sir,—In your January number for the present year I find an article on the "Materialistic Origin of the Sexes," by Mr. Andrew Dewar, who is described as the author of the "Origin of Creation." Turning to your notice of that work (1875, p. 353) I find that the author desires to be judged "by the light of their (the readers') faculty of common sense and their own personal observation, without reference to any book whatever, except it may be the Scriptures." Is it not somewhat strange to find a writer who accepts the Scriptures as a scientific authority coming forward to clear difficulties out of the way of Materialism?—I am, &c.,

An Old Subscriber.

"NATIONAL SCIENTIFIC APPOINTMENTS."

To the Editor of the Journal of Science.

Sir,—Having for the first time in my life met with a file of the "Journal of Science" among a number of valuable and thoughtful articles, I have been particularly struck with the paper in your number for November, 1879 (p. 723), bearing the title which I have quoted. You will perhaps not deem it an impertinence if I give a guess at the motives of the authorities in their most unfair and absurd arrangement of offering, in an examination for the post of assistant in the Natural History department in a museum, 500 marks for elementary mathematics, 1000 for advanced mathematics, 500 for theoretical mechanics, &c., whilst zoology, botany, and physiology count for but 500 each. I believe it is to give an unfair advantage to the candidates who have studied at the public schools and at the old universities, and who, if the examination were confined to biology, as it ought to be, would be simply nowhere. In an examination arranged in the manner you state a zoological specialist must be so handicapped that his success would be a miracle.—I am, &c.,

Fair Play.

INDUSTRIAL TRAINING.

To the Editor of The Journal of Science.

Sir,—The writer of the admirable article on "Industrial Training," in your January number, is evidently unacquainted with the peculiarities of the trade with which I am connected—the boot and shoe trade, as carried on by hand without the aid of machinery. The boys who go to this trade are generally sons of poor men who are unable to pay any premium at all, and therefore the boys are bound for six or seven years, chiefly with a view of compensating the master, as very few boys are worth much the first year or two. Every practical shoemaker would laugh at the idea of taking a boy for three months, or even twelve months, to learn his trade; but I should say that any boy who could learn the trade at all could certainly learn it in three years, and very few indeed in *less* time than that. And this brings me to what I have for years considered the greatest difficulty connected with this subject, and which the writer of the article in question but barely alludes to—the capacities of the boy for the trade he is about to learn. I have not the least hesitation in saying, and I speak with the authority of knowledge, that not one boy in ten of those who have been put to my trade have become good craftsmen. After trying for seven or more years, spoiling a great deal of leather, exhausting the patience of a number of instructors, and disappointing parents and master, they might in a short time become clever gardeners, engine-drivers, painters, lecturers, or even preachers, but *never could learn to make a shoe.* A large proportion of those who have been put to this trade forsake it in disgust when "out of their time," and therefore I think the great desideratum is a method of ascertaining the boy's capabilities for the trade before he is finally "bound to it."

I know not whether the same difficulty applies to other trades, but, if so, what is the remedy? Probably the writer of the article in your excellent journal may be able to suggest one.

Would it be practicable to institute preparatory industrial schools or colleges, or to connect departments of that kind with some of the present schools?

If you think this letter worth publishing you are at liberty to do so, or to submit it to the writer of the article in question.—I am, &c.,

John Bell.

CHEMISM AND THE SEXES.

To the Editor of the Journal of Science.

Sir,—If the duality of properties found in the elements is to be taken as a simple expression for sex, we ought at least to find such duality absolute. The behaviour of such a body as oxygen introduces a factor certainly not represented in sexual phenomena, and I think upsets the analogy drawn by Mr. Dewar in your January number. When Berzelius, applying his electro-chemical theory to the explanation duality, divided the elements into + and − groups, he himself, though imbued with the spirit of Lavoisier, recognised that the distinction was a *relative*, not an absolute one.

Mr. Dewar says "No natural production can be found containing the elements of only one class," and that "combination cannot be produced among the elements of one class only." Surely he must be acquainted with carbon dioxide, and with the formation of, say, sodium amalgam (which is attended, by-the-bye, with the production of that "old element" flame). Apparently, however, your contributor did not trouble himself about elementary facts while evolving his theory, for he describes air as a dual *combination* of oxygen, nitrogen, and *hydrogen!* Mr. Dewar argues for the death of Materialism with the failure of his hypothesis, but it is an elementary chemical fact that compounds may have properties totally different from those of their elements,—therefore to prove that matter contains within itself the "potency of life" one need not seek in the elements the properties of a definite compound, viz., Protoplasm.—I am, &c.,

F. G. H.

SIMULATION OF ANIMALS TO PLANTS.

To the Editor of the Journal of Science.

Sir,—In "Tropical Nature" Mr. Wallace remarks on the simulation which naturalists on the Amazon observed in the insect tribes. Sir F. B. Head, in his "Journey across the Pampas," says he "constantly observed the singular manner in which all animals, particularly birds, are protected from their enemies by plants and foliage which resemble them." In his journey across

the great Cordillera he saw "large tawny-coloured fungoid-looking substances which in size, shape, and colour resembled lions (pumas) lying on the ground." So great was the likeness, he says he "could not distinguish whether they were (pumas) or not" (p. 77). Speaking of the parrots, he says, "The plumage of the breasts is always of the most gorgeous and brilliant description, but their backs are invariably of the colour of the country they inhabit. In the region of woods it is generally green and bright yellow—they are of these hues; in the plains of grass their backs are a mixture of brown and green, and they so resemble the surface of the country as they skim over it that it is as difficult to trace them as it is the partridge when flying over ploughed lands" (p. 126). These facts appear to support Mr. Wallace's theory of colour in birds as contra-distinguished from that of Mr. Darwin.—I am, &c.,

S. B.

NOTES.

The Threatened Epidemic of Small-pox.—London is apparently once again threatened with an epidemic of small-pox: the disease is described as marching on the metropolis from the south-east, and as being sporadically present in the south-west, and districts apparently unconnected with each other. It has been the custom for some years back to attribute the origin of small-pox, as of other *zymotic* diseases, to such causes as filth, *fermentation*, specific poison, and so on, its propagation to contagion. We should be glad to have the views regarding the present outbreak of those who would thus account for the large class of diseases of which small-pox is one. As a matter of fact, the recurrence of small-pox, typhus fever, and some other diseases, takes place at regular intervals of time, and, as far as we are able to see, without any difference in conditions as regards filth, or rather cleanliness of places, on such occasions from what prevails during its absence. Communication between persons is no greater during its presence than while small-pox is absent: if, therefore, the extension of an epidemic depends upon contagion alone, how are we to account for its cessation after having prevailed in a locality for a certain defined time? These and kindred questions bearing upon epidemiology are perhaps easier put than answered.—*Medical Press and Circular.*

According to Dr. Berkhan ("Zeit. für Psychol.") marriages between normal men and cretin women are sometimes prolific, but the children usually die during childhood.

M. Cœurdevache (singular name!), of the meteorological observatory in the Park of Saint Maur, finds, from a series of special observations, that the lowest mean diurnal temperature in the months of March, April, and May, occurs about the 20th and 21st day of the moon.

A writer in the "Times" complains in bitter terms of the cost of the Geological Survey of the United Kingdom. The "Geological Magazine" points out in reply that, considering the difficult nature of their duties, the men employed are not overpaid. One of them, after working for twenty years, receives £180 yearly, and another, who has served over thirty years, receives £219!

According to the "Scottish Naturalist" a hoopoe was seen in Unst in October last, and paid the usual penalty for appearing on British ground. Its stomach was found filled with earwigs,

—a fact which furnishes a powerful argument for the preservation of this harmless and beautiful bird.

"The Victorian Year-Book for 1879-80" gives a curious ethnological fact. Of every 1000 native-born Victorians the proportion of criminals is 11·18; of natives of England and Wales, 40·23; of Scotland, 39·91; of Ireland, 80·36; and of China only 12·64! Hence an Englishman or Scotchman is more than three times, and an Irishman more than six times, as likely to commit crime as the much-denounced Chinaman.

According to M. E. Allary ("Bulletin de la Soc. Chimique de Paris") the proportion of iodine in sea-weeds ranges from 1·224 kilos. per 1000 in the fresh leaf of *Digitatus stenolobus* to 0·007 kilo. in *D. bulbosus.*

According to the "Dundee Advertiser" certain bees in New South Wales having suffered from drought, made provision for such an emergency by storing a large number of cells in every hive with water. Pending the confirmation of this singular anecdote we reserve comments.

Prof. Lister, F.R.S., in an Address delivered before the British Medical Association on "Micro-Organisms and their Relation to Disease," observed very justly that if the researches of MM. Pasteur and Toussaint should lead to nothing more than what seems to be already on the point of attainment,—the means of securing poultry from death by "chicken-cholera" and cattle from the terribly destructive splenic fever,—it must be admitted that we have an instance of a most valuable result from much-reviled vivisection.

We are happy to learn that a Civil List pension of £200 annually has been conferred upon Mr. A. R. Wallace, in recognition of his splendid services to biological science.

Mr. J. C. Branner communicates to "Science" some observations on the habits of the Brazilian "Cambota" (*Callichthys asper*). He watched one of these fishes travel a distance of 90 metres on dry ground.

According to the "Medical Press and Circular" a woman at Ipswich, of the name of Lockwood, has not taken more than a pound of solid food during the year 1880. Since September she has partaken of nothing but a few drops of weak tea. She is sometimes in a state of coma for days together.

The same journal announces that another of the London hospitals is in danger of entering upon a career of rampant "nursedom."

It is somewhat significant that in the poem in which the Laureate has recently libelled the medical profession he contrasts an angelic nurse with the coarse, unfeeling doctor.

According to Biedermann's " Central-Blatt " the fat of animals in a natural condition is richer in solid fatty bodies than that of such as have been artificially fattened, and is therefore preferable for use in manufactures.

Mr. F. M. Webster, of the Illinois State Laboratory of Natural History, is engaged with some interesting researches on the food of beetles, considered from an economical point of view. He finds that many of the Geodephaga are less exclusively carnivorous than has been taken for granted, and are even occasionally injurious by destroying seeds, the stems of plants, &c. He confirms the Aphis-eating character of the Telephoridæ.

The Council of the Entomological Society of London has formally petitioned against the proposed railway from Chingford to High Beech, as calculated to lay waste a part of Epping Forest very interesting to naturalists.

According to Dr. E. C. Spitzka (" Science " and " St. Louis Clinical Record "), in " Schenck's Lehrbuch der vergleichenden Embryologie der Wirbelthiere," p. 137, is figured a section taken flatwise through the embryonic human paw. The chondrogenic elements of the mesoblast can be seen arranged in strands, indicating the metacarpo-phalangeal rays. A *sixth* ray seems very clearly present. At different periods these cell-strands are not five, but from seven to nine in number. This fact points to the descent of man and the pentadactylous animals from the Enaliosaurians or analogous groups of the Jurassic and Triassic Epochs, whose remains show seven or more fin-rays. Hensen, of Kiel, found in the human embryo of the seventh week the fingers and toes provided with claws like those of the Carnivora, which are exfoliated to make way for true nails. He found also plantar and palmar eminences, like the foot-pads of the dog, cat, and carnivorous marsupials.

The " American Naturalist " declares " the cultivators of natural history imbibe their early love for Nature during their out-of-door early life in the country. Nearly all our leading naturalists were country-bred boys."

H. Michels has investigated, with great care and exactness, the changes of the nervous system of Coleoptera during their metamorphosis.

The Emperor of Germany has defrayed the expense of the excavations at Olympia out of his private purse.

An article in the " Kansas City Review of Science," criticising the philosophy of Mr. Herbert Spencer, contends that there is beneath the laws and forms of nature an Agency to which design and purpose can scarcely be denied.

Sagacity in Animals.—Mr. Haygrath ("Bush-Life in Australia") says "We had a half-tamed native dog, 'dingo' or 'warragee,'" chained in a small enclosure into which a merino ram accidentally strayed. Not seeing his way out he "prepared to attack his natural enemy." The dog "stood out as far as his chain would admit" and awaited the onset. The ram "retreated backwards to some distance, and rushed on his foe . . . with an impetus which would have felled an ox." When the blow "seemed inevitable," the dog suddenly crouched down and "seized his antagonist firmly by the throat as he flew over." The ram would have been killed but for our interposition (p. 116). Speaking of the "dingo" in his simulation of death, he says—"Its most striking peculiarity is its tenacity of life." "As a last resource it has a remarkable trick of shamming dead, . . . when it may be dragged by the heels and well-belaboured without flinching—lolling its head listlessly down as if quite lifeless, until a fair opportunity of crawling away presents itself" (*ibid.*). Speaking of the half-wild oxen, he instances the remarkable instinct they possess of locality. He says—"They have been known 'to make back' through every obstacle for hundreds of miles; and animals that have escaped from the very slaughter-house in Sydney have been found again, within a short time, on their former feeding-grounds at a vast distance in the interior." That sometimes settlers, when changing their stations, send their cattle by a circuitous route, "by way of mystifying their troublesome organ of locality;" but it has been found, "both by tracks and by sight, that the stragglers . . . have returned by the direct line through a country of which they had not the slightest knowledge." Another time he was expecting supplies, when "the pack bullock, with his load on his back, arrived without any driver." In anxiety as to his fate he followed the animal's track, which "had never been once at fault, or even stopped to feed." Sixty miles from the station he "found the driver alive and well, but in great tribulation for the loss of his charge, and was satisfied when told "that the animal, more sagacious than himself, had reached his journey's end safely" (*ibid.*, p. 57)

Our ably-conducted contemporary, "Science," gives abstracts of papers—by O. C. Marsh, on the Limbs of *Sauranodon;* by E. S. Morse, on the Identity of the Ascending Process of the Astragalus in Birds with the Intermedium; by H. C. Chapman, on the Placenta and Generative Apparatus of the Elephant, and, by the same author, on the Structure of the Orang-Outang.

According to Prof. Elias Loomis the centre of a cyclone has never been found within 6° of the Equator.

We learn that the Medical Officer of Health at Govan Hills receives a salary of £12 yearly, in consideration of which he is to give medical opinions when required, to make examinations, submit reports, and attend court if needful!

A writer in the "Journal of the Society of Arts" complains that "the ordinary run of tenants do not care and will not pay for properly constructed houses." True, because they have already to pay to the full extent of their means, and perhaps beyond, for improperly constructed ones!

Dr. J. H. Gilbert, F.R.S., doubts, on very substantial grounds, the alleged superior value of bread made from the entire wheat.

Prof. Broadhead, in a paper on the distribution of the Mastodon, communicated to the "Kansas City Review of Science and Industry," refers to traditions proving that this animal must have coexisted with the Red Indians.

On the Grains of Silica and Micrococci of the Atmosphere. By Dr. T. L. Phipson, F.C.S., &c.—At the period of the great debate on spontaneous generation between M. Pasteur and Pouchet, the latter was the first to draw attention to the fact that some of the minute spherical granulations discovered by the microscope in dust deposited from the air in various regions of the globe were essentially composed of silica. That they had often been mistaken for eggs of Infusoria or for Micrococci was very evident, but when the dust was submitted to complete calcination in a platinum crucible the same grains were still visible, with the same forms and dimensions as before. I have more than once repeated this experiment of Pouchet's, but I have also made the opposite one, and examined the action of heat upon Micrococci, diatoms, and Oscillariæ, which are supposed to contain large quantities of silica. There is no doubt but that the dust of the atmosphere reveals to the microscope, besides the larger mineral fragments mostly of an angular shape, exceedingly minute circular and spherical bodies, having often not more than 0·001 of a millimetre in diameter, and very similar in size and shape, which resist the action of a white heat in contact with the air and that of strong hydrochloric acid. In some of my observations they were remarkably numerous. Both before and after the action of heat they are more or less transparent. What can be the origin of these singular objects? The same experiments repeated with siliceous Algæ, such as those belonging to the large family of the Diatomaceæ and with the Micrococci of impure waters or vegetable infusions, showed me that they do not retain their forms after being subjected to the above treatment, and that in many instances they can be totally destroyed by heat on the object-glass itself. On the other hand, the fossil diatoms resisted the action of heat, and retained their forms. I can only draw one conclusion from these observations, namely, that the minute siliceous bodies found in the atmosphere are also fossil; they are Micrococci of another age.—*Chemical News.*

According to MM. Kühne and Steiner ("Untersuchungen aus dem Physiolog. Institut zu Heidelberg," iii., p. 327) the electric

fluctuations produced by light in a retina provided with the "visual purple" are different, both quantitatively and qualitatively, from those where the purple is absent.

According to H. Hoffmann ("Naturforscher," xiv., No. 3) the damage done to trees by frost is greater in the valleys than on hills, and greater in southern than northern exposures. There is not a fixed degree of cold necessarily fatal to trees of a certain species, but the injurious effect depends on the extent of the variation when a thaw occurs. A cold of -17 followed by a sudden rise to $+3$ is not more hurtful than a cold -10 abruptly changing to $+10$. For every species the amount of this amplitude is peculiar and fixed. The destruction of vegetation in warm aspects after a severe frost is noticed by Gilbert White ("Selborne," Letter LXI.).

According to J. Reinke ("Botanische Zeitung," 1880, No. 48) protoplasm contains, as its immediate constituents, plastine, viteline, myosine, peptone, peptonoid, pepsine, nucleine (?), lecithine, guanine, sarcine, xantine, ammonium carbonate, paracholesterine, traces of cholesterine, ethalium resin, a yellow colouring-matter, glycogen, a non-reductive sugar, oleic, stearic, palmitic, butyric acid (traces), carbonic acid, glycerides and paracholesterides of the fatty acids, calcium stearate, palmitate, oleate, lactate, oxalate, acetate, formiate, phosphate, carbonate, sulphate, a magnesium salt (probably a phosphate), potassium phosphate, sodium chloride, iron (in an unknown state), and water! The author obtained his material from the fruits of *Ethalium septicum*. He finds that protoplasm contains scarcely 30 per cent of albuminoids, and cautions the reader that this substance can no longer be spoken of as a coagulum of white of egg. Chemically speaking the protoplasm even of the lowest organisms possesses a very complex structure.

"Science" comments somewhat unfavourably on a lecture, illustrated with experiments, delivered by Dr. Beard before the New York Academy of Sciences, on "Mesmeric Trance."

Among the lectures to be delivered at the London College of Surgeons we notice a course on the "Structure of the Skeleton in the Sauropsidæ," by Prof. Parker; and a course, by Prof. Flower, on the "Anatomy, Physiology, and Zoology of the Cetacea."

Dr. S. V. Clevenger, in an interesting paper in "Science," suggests—basing his views upon the observations of Dr. Drysdale and the Rev. W. H. Dallinger, on the Amœba—that the sexual appetite is in its origin a transformation of hunger.

According to the Detroit "Lancet" the Boston physicians have adopted, as a part of their future code, the following:—A physician should not append his name, or permit it to be appended, to certificates in laudation of speculative health resorts,

health excursions, nutritive or dietetic preparations, proprietary formulæ, wines, mineral waters, beverages of real or supposed medicinal efficacy, or other hygienic materials."

M. A. Sabatier ("Comptes Rendus," xcii., p. 200) has made some interesting observations on the formation of the blastoderm in the Araneida. Their eggs present a type intermediate between those of the Crustacea (*Peneus*) with a general superficial segmentation and such with a regular discoidal segmentation, like those of certain fishes. The affinity of the Araneida with the other groups of Arachnida and with the insects is very distinct.

According to a paper read by M. Pasteur, before the Academy of Sciences, the saliva of a child, dead of well-pronounced hydrophobia, when introduced beneath the skin of rabbits, proved fatal in thirty-six hours. The symptoms, however, were quite distinct from those of rabies. In every case the blood of the deceased animals contained microscopic organisms of the form of a short rod, a little constricted about the middle. Each was apparently surrounded by an aureola of a mucous substance. Guinea-pigs resist the new disease, but dogs perish with symptoms quite distinct from those of any type of rabies.

According to Miss S. P. Monks ("American Naturalist") the larvæ of the dragonfly (*Æschna*) use their power of ejecting a stream of water from the branchial apparatus at the hinder end of the body as a means of defence.

Mr. E. B. Wilson places the Pycnogonida intermediate between the Crustacea and the Arachnida.

In the same journal is an account of some important experiments on the action of Pyrethrum powder upon cabbage caterpillars, potato-beetles, aphides, mosquitoes, and other noxious insects. The results were satisfactory except in the case of *Coreus tristis*, a bug which infests vegetable marrows.

Baron von Reitzenstein (Psyche) describes an aquatic lepidopterous larva belonging to the family of the Sphingidæ (genus *Philampelus*). It feeds on water-plants and swims well.

According to the Report of the Mining Registrars of Victoria, for the quarter ending September 30, 1880, the total quantity of gold obtained has been 222,014 ozs. 16 dwts. The bullion exported was 58,080 ozs. 19 dwts., besides specie to the amount of £1,117,286.

Mr. Lester F. Ward contributes to the "American Naturalist" a most interesting paper, on "Incomplete Adaptation as illustrated by the History of Sex in Plants." He argues that adaptation is never absolutely complete.

In the same journal Miss S. P. Monks gives a valuable biography of the American green lizard (*Anolis principalis*), and Mr. G. K. Morris an account of a new leaf-cutting ant, an *Atta*, which inhabits the coast of New Jersey. The editors, Messrs. A. S. Packard, jun., and E. D. Cope, denounce, with well-merited indignation, the import-duty of 10 per cent levied in the United States on specimens in natural history. The English sparrows introduced into America have been found to construct winter-shelters quite different from their breeding nests.

M. Maquenne ("Annales Agronomiques," vi., 321) has made a series of researches on the absorption and radiation of heat by leaves. He concludes that all leaves dissipate a part of the heat which they receive vertically. This dissipation takes place in general more from the upper than the under side. Their power of absorbing heat is due to the presence of chlorophyll and water, and is greater in thick leaves than in thin ones.

Prof. F. Schultze has produced an interesting work on the development of speech in children, in which he traces analogies to the rise of speech in the human species.

Dr. Schimper ("Botanische Zeitung," 1880, No. 52) finds that even in the non-chlorophyllaceous cells of plants there are organs which produce starch. These organs are undeveloped chlorophyll granules which are capable of being converted into chlorophyll under the influence of light.

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THE

JOURNAL OF SCIENCE.

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I. THE ORGANISATION OF MATTER.

By Charles Morris.

In my article published in the "Journal of Science" (March, 1881) certain principles of aggregation of matter were applied to explain the original formation of the spheres. It was, at the same time, remarked that these principles applied to the formation of the minor elements of the spheres, and that the whole of concrete matter was probably organised under their influence. In the present article I design to apply the hypothesis to the formation of atoms and molecules.

If the matter of the spheres in their present state has only partially lost its original irregularity of motion, in the earlier nebulous state this irregularity was still more declared. After the great regular movements were produced—the cosmical motions of spheres as wholes—the same process continued to act upon their minor elements, to the production of smaller aggregations of accordant motions. In a vast mass of nebulous matter, moving in one direction, through a partial loss of the motion of its particles in the opposite direction, we can imagine its minor portions as gaining accordant motions, and separating from each other, in the same mode as the mass as a whole separated from similar masses of nebular substance. These minor portions would attract accordant motions and repel discordant, precisely as the mass as a whole had done. Thus small masses would gather out of the material of the large mass, some of them attractive, others repulsive, to each other, according to their directions of individual motion. Each, as a whole,

must have moved through space in the common direction of motion of the general mass, but its remaining motive vigour may also have become partly accordant, yielding it individual mass motion of its own, in some special direction. The individual motions of the minutest elements of the nebula would thus, through partial loss of motion in certain directions, become combined motions of minor aggregations of these elements in the opposite directions. But the direction of motion in these small masses would be subject to frequent changes through impact with other like masses.

It may be well here to consider an essential distinction between the results of impact and directive energy. An axiomatic phrase will indicate this distinction. Impact is centrifugal in its influence, attraction is centripetal. It may further be premised that impact is instantaneous, attraction and repulsion are gradual; impact yields straight lines and fixed speed of motion, attraction and repulsion yield curved lines or varying speed; impact acts immediately and through contact, attraction and repulsion act persistently, and from a distance.

Did impact exist alone all force would be centrifugal; there could be no organisation, and heterogeneous matter would perhaps tend to become homogeneous. It certainly could not tend to greater heterogeneity. All organisation results from the action of directive force, and the production of accordance between the motions of particles, under its influence. Attraction produces not a single initial change of direction and speed,—like impact,—but a continued series of such changes, and causes uniform motion in straight lines either to become motion in curved lines, or to accelerate or diminish in speed, according to the direction from which the force acts. This is the first specialisation of motion. It acts to reduce the amount of centrifugal energy, by bringing motions into parallel relations, and thus reducing the frequency of impact. Similar effects are produced by repulsion, but they differ from those of attraction by being gradually diminishing instead of gradually increasing effects.

The second specialisation of motion is produced when from the open curve proceeds the closed curve, motion in straight lines having thus changed into motion around a centre of attraction. In this condition of motion its centrifugal energy vanishes; all its force has become centripetal. And such a condition is essentially a persistent one. The centre of attraction around which the motions rotate owes its vigour to these motions, and thus must retain them in

persistent allegiance. Should the earth come into contact with any exterior body the impacting energy would be only that of its motion through space, not that of its rotation on its axis.

And another important question arises here. This is the question of the origin of the rotatory motion. Is it a transformation of the mass motion through space, or has it some other source? If the former, the particles must cease to move through space without a transfer of their motion of translation to any other substance. Motion in one direction would change of itself into motion in two opposite directions. Yet such a result is impossible. If the motions of the universe are accurately balanced in direction, no substance can lose its motion through space except by transferring it to some other substance. This is a fundamental principle of physics.

In a motion of rotation there is equal movement in even two opposite directions. For the location of the centre of gravity of a mass depends on there being the same quantity of momentum on every side of it. Therefore, if it were possible that the quantity of momentum in any direction could be reduced, the centre of attraction would necessarily shift its position so as to restore the balance. But such a balance, once existing, could never be lost, since the energy of one hemisphere must forcibly compel an equal energy in the opposite hemisphere.

Such a balance of motion in all opposite directions existed in every original mass ere rotation commenced, being what we know as heat vibration. Unless in the improbable contingency of the direct motion of the mass embracing all its energies, through the loss of all reverse motion, some fraction of this energy must exist as heat motion. And this heat energy must be of equal vigour in every direction; for if it were in excess in any direction, this excess would become new mass motion, either of the whole or a separated portion of the mass, or else would be lost as exterior impact, and leave the remaining motions in exact balance. The particles of the mass must therefore, in their individual motions, possess an equal vigour in every direction. But for rotation to arise something more than this individual balance is requisite.

In any mass of matter possessing an excess of direct over reverse motions, and therefore an excess of attraction over repulsion, this attraction, exerted between all the particles of the mass, necessarily generalises, and becomes in effect a single attraction exerted from the axis of movement of the

mass, its greatest vigour being at the centre of this axis, or the general centre of all the accordant momentums of the particles, and of the individual attractions of the atoms, if the mass is composed of atoms.

But any motion towards such a centre tends to vibrate through it; any motion transverse to it tends to change from a straight to a curved line, this curve arching inward if the motion be attractive, outward if it be repulsive. Thus around the centre of attraction of such a moving mass all accordant motions would bend into curved lines, the whole mass tending to rotate around its general centre of attraction.* But if its substance was perfectly homogeneous in condition this tendency would be equal in all accordant directions, and no rotation could result, the resisting impacts being exactly balanced. But if—as most probable—it was heterogeneous, the impacts would cease to be equal. There might readily occur an excess of motion in one direction near the centre, the point of strongest attraction. Such a motion would have an advantage over all more distant opposite motions. Its tendency would be to repel the reverse motions, and to move around the centre with a radius depending upon the degree of curvation. There would be a new series of accordant motions, yielding a new attractive energy upon accordant, and repulsive energy upon discordant motions. The original sorting out of directions of motion, under the influence of the motion of the mass through space, would be followed by a new sorting process under the influence of rotation of the internal portion of the mass around its centre. The central motion thus inaugurated must gradually extend its influence outward through the mass.

This new series of parallel motions set up in the mass would not necessarily be around the original axis of mass motion, but might be around a new axis of rotation, at some angle of accordance with the direction of mass motion. In such a process of formation the opposite axes of curvilinear motion must move reversely to each other, and therefore repel. Thus the circles of motion would tend to expand, the centrifugal energy of rotation being aided by

* Such curved lines of motion arising in one hemisphere of a globe are not produced by an attraction actually residing at the centre, but by the attractions of the opposite hemisphere. But these attractions are mutual, and their results must be equally balanced. The variation from a straight line of motion in any particle must be met by an equal opposite variation in some other particle or particles. No particle is fixed and incapable of variation in direction, and therefore the fixed balance in opposite directions of motion cannot be disturbed by any such mutual exercise of attraction.

this influence. This centrifugal energy might be such as to give the globe a discoid shape, or even, in the case of small masses of matter, to open it out into an annular ring, all the matter being repelled from the centre. The centrifugal energy would necessarily limit the size of the aggregation. Its attractive vigour would, of course, depend upon its quantity of parallel motion. But the force of attraction regularly decreases, and that of centrifugal energy regularly increases outwardly, so that at a fixed limit of distance the attraction would cease to control the momentum, and the possible size of the minor aggregations of matter be thus exactly fixed.

Such a minute aggregate of matter, locking up within its mass a certain quantity of momentum, would constitute an indestructible unit, the primary atom. The loss of any portion of its material, through impact, might readily be replaced through its attractive influence over the accordant motions of the surrounding ether, and thus its continued integrity be assured.

The attractive energy of such atoms must act outwardly as well as inwardly. But it would no longer be confined to its simple primary relations. There being a specialisation of direction in the motions of the atom, there would be a specialisation in its attractions and repulsions. The secondary aggregation into chemical units might possibly result from the direct coherence of two or more atoms into one mass, each retaining its original centripetal centre. And such coherent masses, acting as units, might unite again into still more complex masses, this process or combination continuing until not only the most intricate chemical elements, but the most complex molecules were formed.

The original atoms would be all similar, or would consist of a limited number of diverse kinds, each kind arising from a fixed decrease of temperature in a homogeneous portion of the ether. The complex atoms might vary in the number of their included simple atoms, the variation increasing as these secondary atoms became units in still more complex aggregations. At every step upwards the number of possible molecules would increase, this number becoming very great in the chemistry of the organic world.

In this process, however, the specialisation of motive conditions must rapidly increase, the original general attraction becoming more and more selective in character as the intricacy of motive relations become more declared. The whole tendency in this continued aggregation of ether must be to the production of harmonious relations of motion, a reduction

of centrifugal impact, and a loss of repulsive energy as motions become parallel and attractive.

Yet even in the most condensed spheres of space a large quantity of centrifugal force continues to exist, resulting from the original mass motions of atoms, and constituting the individual or the temperature motions of chemical molecules. This individual energy is most free and declared in the gaseous form of matter. In the gas harmony of motion is confined to the interior and the cosmical relations of the molecules. In their heat motions, as unit masses, they retain the individuality and irregularity of motion of the original ether. This energy is centrifugal. It yields impact force through their incessant collisions, by which they are driven back in straight lines in every conceivable direction.

The molecules of the atmospheres of the planets are only partly free in their motions. They must conform to all the regular motions of the planet. Their irregular motions are only the excess of motive force over these regular motions. They are also subject to the condensing force of inward attraction and outward pressure, thus increasing, through contiguity, the attractive energy of the particles of the gas upon each other. Thus the same influence is brought into action that acted upon the original ether. Attractive force tends to produce curved lines of motion in the gas. A loss of temperature, as before, decreases the centrifugal energy and increases the centripetal, until, finally, the curves become closed, and a new aggregation of matter results. The centrifugal heat vigour of the gas becomes centripetal, motion in straight lines becomes motion around centres of attraction, and the liquid form of matter replaces the gaseous. A new specialisation of matter has taken place, and the centrifugal energy of nature is still further replaced by the centripetal, through the increased harmony in motive direction. The free motions of the gas particles have become converted into the normal organising motions of the liquid.

But the impacting energy of gaseous molecules is also reduced by attraction in another mode. We have so far considered the attracting energies as acting from one side only. In irregular masses it thus acts from the side of greatest condensation. In regular masses it would act equally from both sides. The tendency there would not be to produce curved lines of motion, but to accelerate the motion of approaching, to diminish that of receding, particles. In short, vibration would result. Such vibratory motions are probably of frequent occurrence in gases, and

reduce to some extent the number of centrifugal impacts. In another form of matter, the solid, they constitute the regular condition of temperature energy. In this form the attractive energy has become so greatly enhanced through contiguity of particles, and the impact energy so greatly reduced, that vibration has become the normal mode of temperature motion, and impact has become abnormal, instead of normal as in gases. There is no tendency here to the curvilinear mode of motion. The aggregation in solids has become so regular that attractive vigour acts equally from all sides, its natural result, therefore, being the vibration. If a gas could retain a homogeneous state of condensation while continuing to lose temperature energy, it might at once pass into the solid state without entering the intermediate liquid condition. It would simply need that the attractive energy should become stronger than the temperature energy for the motion in straight lines to become vibrating motion, and thus for the solid state to be assumed.

But gases are ordinarily heterogeneous in aggregation. Attraction acts more vigorously from one side than from the other. Curved motions result. The closed curve finally arises, and the liquid form is produced. From this the solid is more easily constituted. The motions in liquids are far more regular than in gases. A much greater homogeneity of aggregation exists. The curve, affected by equal forces from both directions, tends to become the vibration, and the solid thus readily arises from the liquid.

The gas, therefore, may be reduced to the liquid or the solid state by attraction overcoming momentum in two diverse modes. Attraction in a regular mass of particles tends to produce vibration; in an irregular mass it tends to produce rotation. Yet it does not follow that these two results arrive at the same degree of reduction of temperature. The vibrating particles constantly increase their distance from the attracting centre, the vigour of this attraction thus rapidly decreasing. They also enter new fields of attraction which strengthen their motive vigour. Thus the lateral attractions which converge upon the centre of motion of the particle must be powerful enough to bring it to rest ere it can feel the full vigour of a new attractive field. In curved motion, on the contrary, the particle is held at a regular distance from the centre of attraction. This force does not diminish through increasing distance, nor is it overcome, to the same extent, by the influence of more distant centres. Thus a less degree of energy is necessary to produce the closed curve than is required to yield the

vibration as a normal condition, and matter enters the liquid state at a considerably less reduction of temperature than that required to produce the solid state.

Throughout the whole process one general principle holds good—a constant tendency to homogeneity. Motion becomes more and more regular from the ether to the solid. It first becomes regular and centripetal in its energies in the atom. Then the irregular mass motions of atoms become reduced by their aggregation into molecules. The irregular motions of gas molecules become partly regular in the liquid form, and wholly so in the solid; for it is probable that in the interior of a crystal attraction is the only mode of energy, the vibratory swing of the particles being synchronous, so that no contact takes place between them. In such regular solids, therefore, it is probable that the molecules are arranged with complete regularity, that impact force occurs only at their point of contact with exterior substances, and that in their interior conditions only the centripetal energy of attraction is exercised.

In the original formation of the spheres a complete homogeneity of the mass might have prevented the liquid condition of rotation being assumed, the mass gradually condensing and solidifying, without assuming rotation either as a whole or in its minor portions. But such homogeneity is practically impossible in any large aggregation, and the liquid phase of matter, therefore, always precedes the solid.

On conversion of the gas into the liquid form a certain result arises as a necessary consequence of the changed relations of the molecules. In the gas they possess a vigorous centrifugal energy. Their motive vigour is constantly exercised in beating back the surrounding molecules, so that each retains for itself a considerable free field of action. As pressure increases and its field of action diminishes, its number of impacts increases in accordance, so that its resistance remains in equilibrium with the pressure. But on reduction to the liquid state this centrifugal energy is suddenly converted into centripetal. The resistance is greatly reduced, while the pressure remains the same. Thus the liquid mass becomes greatly condensed, the particles being driven inwards towards the centre around which they rotate. Yet in the liquid we find a condition that does not exist in either the gas or the solid. In the former, increased pressure condenses the mass by reducing the field of movement of the molecules and increasing their number of impacts. In the latter it condenses the mass by raising the pitch of vibration, or causing the molecules to move more

rapidly in a contracted space. In the liquid neither of these results can occur. The diameter of the circle of motion is governed by the relations of the rotating speed to the central energy, and cannot be changed by any exterior force. It resists pressure, therefore, with great vigour. While the particles of the liquid readily change places, the liquid as a whole refuses to yield to pressure, the centrifugal energy of its innumerable circles of motion not admitting of being packed into smaller spaces, as in the gas and the solid. It is the rigidly elastic phase of motion.

There are certain relations existing between the three forms of matter which require to be now considered. We refer to what has been known as latent heat, the disappearance of heat energy when solids become liquids, or liquids become gases, and its reappearance in the reverse cases. This seeming disappearance and reappearance are a necessary result of the inter-relations of the three forms of matter.

If we consider a molecule of a solid as coming into contact with a molecule of a liquid, at the same temperature, is it probable that they would have the same impact influence upon each other? Suppose, for illustration, we should strike with a pointed hammer upon a mass of liquid of the same weight, stopping the blow at the instant that the point of the hammer meets the surface of the liquid. Evidently there will be a much greater disturbance in the liquid than in the solid. It is a simple question of resistances. All the material of the hammer resists on the one part, while only a small portion of the liquid resists on the other. Thus the slight vibration which runs through the substance of the solid is paralleled by a considerable disturbance of the substance of the liquid.

This illustration applies exactly to the contact of single molecules. Each molecule of the solid is held vigorously in place by the surrounding attractions. The molecule of the liquid is held more feebly in place. The whole substance of the solid aids vigorously in the resistance to impact, while a much slighter resistance exists in the liquid. Thus the solid molecule strikes the liquid with the force of a minute hammer with a molecular point, while the liquid molecule strikes back with little more than its individual force. Therefore every stroke of molecule on molecule has the real effect of a considerable number of solid molecules striking a much less number of liquid. How can this advantage in the solid be obviated? Evidently if the liquid molecules is not sufficiently aided in its resistance by its fellows, it must possess

an extra vigour of individual resistance. It must be strengthened in itself to meet the combined assault upon it. It must, in short, possess much greater momentum than the solid molecule to give it an equal resisting energy.

This extra momentum is extra temperature energy, which is needed to place solids and liquids in equilibrium, as regards their radiant force ; and it is this which constitutes the so-called latent heat of liquids. Similar temperatures in liquids and solids really require a much greater motive vigour in the slightly resisting liquid particles than in the rigidly linked solid particles, and this extra motive vigour must be absorbed before they can become equal in centrifugal energy.

The same principle holds good between liquids and gases. In the latter the resistance is still more reduced. The molecule is largely individual in its energies, being but slightly aided by its attractive relations with surrounding molecules. Thus it again is at a disadvantage as compared with the liquid, and needs a much greater vigour of impact in itself to balance that portion of resisting or impacting vigour which the liquid molecule borrows from its neighbours.

In the reverse process the opposite result occurs. In the gas becoming the liquid it finds itself possessed of a great advantage in resisting vigour, and yields momentum to the slightly resisting gas until the latter gains equality of resistance by a great increase in the impact energy of its particles. A like result occurs in the change from liquid to solid.

This principle probably extends backward unto the simplest form of matter, every new integration from the original ether needing a smaller quantity of impact energy than is possessed by the more simple forms to put it into temperature equilibrium with them. The more individual the particle becomes the greater personal vigour it needs, its resistance to impact being less aided by the force of contiguous attractions.

There are other characteristics of matter which probably arise from the causes above mentioned. As we have said, increased external pressure upon a solid may raise the pitch of vibration of its particles, by forcing them to move in a smaller space. Increased temperature may perhaps have a like effect. Expansion of the mass here causes increased pressure, and may thus produce a higher vibratory pitch, this rising until it becomes sufficiently high to yield the pulsations of radiant heat and light, through all their various grades of pitch.

But as the mass expands the rigidity of connection between its particles decreases. Thus the resistance of its particles to heat impact decreases. It has partly lost the combined energy of impact which it previously possessed, and needs greater individual momentum in its particles to enable them to resist an equal vigour of exterior impact. In other words, its capacity for heat increases as its temperature rises.

In liquids a similar condition exists. They, too, have their normal pitch of heat vibration, which rises as exterior pressure increases. They have also their combined resistance to heat impact, which decreases as expansion increases, their capacity for heat thus augmenting.

In gases these conditions are almost non-existent. The gas molecule is almost entirely free from coercion. Its field of movement may decrease or increase, but it continues to act almost entirely as an individual, and is little subject to the influences which liquid or solid molecules experience from their intimate relations of attraction with their fellows. The pitch of vibration of the gas particle is a resultant of its weight; those of the liquid and solid particles of their combined weight and tension.

If we consider the state of affairs existing in liquids we find a marked absence of rigidity. We may imagine the liquid to be made up of minute spheres of rotating particles, the exterior portions of which are divided in allegiance between two opposite centres of attraction. Such a freedom from special coherence of the exterior shells of such spheres must greatly reduce the frictional resistance between them, so that they may move upon each other with the greatest freedom. In the same manner the least disturbance of the liquid may cause a considerable transfer of allegiance in its particles, the material surrounding each centre of attraction being thus subject to frequent changes. Also any unoccupied space would speedily be filled by a new centre of attraction arising between the particles pressing into it. This constitution of a liquid mass is not apparent to us, from the minuteness of these spheres. But we perceive it in every instance where a water drop has an opportunity to assume its natural shape, it forming a globular mass around a centre of attraction, about which its particles are, very probably, in rapid rotation. Wherever a liquid has a fair opportunity to escape from certain opposing influences, and to display its normal tendencies, the globular shape immediately appears. Ordinarily the liquid has to contend with gravity and atmospheric pressure, and frequently with cohesive

attraction, so that it is reduced to a level surface. Yet the minor aggregations of which it is composed escape these influences, and very likely are globular in form. The liquid, in fact, differs from the gas in that it has lost its impact resistance to pressure, and has become an aggregation of molecules similar to the aggregation of ethereal particles in the atom. Having no mass motion, and therefore no impact resistance, the rotating liquid globes are in contact, their only resistance to pressure being that of elasticity.

As the complexity of molecules increases their attractive vigour diminishes. They cease to combine into the rigid solid, but display in their combinations the globular aggregation of the liquid, forming what is known as the colloid state of matter. These colloid globes are more coherent than ordinary liquid globes, and retain their individuality, instead of readily fusing as liquids ordinarily do. But an incomplete fusion often appears between them, and combines them into coherent masses. Usually, in their individual form, they are not subject to the influences affecting the drop of liquid, since they exist as single masses in liquids, where they are not exposed to pressure. But certain influences, possibly of an attractive or repulsive character, act to overcome the feeble centripetal energy of the colloid masses, and to change their globular into an irregular form. These yield a result not unlike that which pressure and cohesion produce on the liquid drop. The main difference is that the feebler centripetal energy of the liquid drop causes it to readily break up into several individuals, while the colloid is more persistent in its aggregation. Yet new centres of force often arise in its irregular protrusions, or appear in its midst when it becomes of considerable size. In short, it displays curious analogies to the action of liquid drops. These phenomena, however, take place under influences different from those which produce like changes in liquids, and a further consideration of them would lead us from physical into biological science.

One further deduction seems to arise from our premises. Let us define the molecule. We may view it as a single centripetally organised mass of matter, composing a natural unit or individual, and whatever answers this definition should rightfully be classed as a molecular aggregate. The simple atom is thus a molecule of the original ether. From this atom more complex molecules arise, until we reach the most intricate organic molecule. But higher definite aggregations of matter answer to the same definition. They are single centripetal aggregations of minor elements. Such is

the drop of water. It is a collection around a centre of attraction of all the substance which that attraction is capable of condensing. The same thing may be said of a crystal. It is a centripetal aggregation assuming a definite shape around a centre of formation. We may even say the same of a colloid mass, a single animal cell, or a single-celled animal. It is a centripetal aggregation of smaller molecules around a centre of attraction, precisely as the chemical molecules are aggregations of atoms definitely arranged about a centripetal attraction.

We may even pursue this thought further. What is a many-celled animal but an aggregation of colloid molecules around a centre of organisation, a centripetal force which controls and arranges them into a definite and self-limited mass. Thus we perceive the conditions of organisation of the smallest aggregates of matter reappearing, in an advanced stage of development, in the highest aggregates. Each is a unit of organisation around a centre of force, and is limited in its dimensions by the vigour of this force. The principle that governs the simplest aggregate of matter thus governs the most complex. Each self-limited aggregation around a centre of force, from the atom to the man, is a unit of nature, analogous in constitution to all the other units.

These units resemble each other in another particular. They are all polar in force. The atom, as we have argued, is a rotating sphere or ring of matter, with its axis of rotation and its poles, these possibly displaying the magnetic energy. Every molecule has probably one or more axes. Every rotating liquid sphere has its axis and its poles. A complex polar organisation exists in crystals. Finally, a polar organisation is observable in single-celled animals and plants, and undoubtedly exists in the highest organisms.

The tendency of every colloid mass, whether simple or compound, is to become globules. But its material is influenced by exterior forces as well as by the centripetal force. It therefore becomes variously irregular in response to these exterior relations. Such irregularities become permanent since they arise from permanent conditions of exterior force. The plant, for instance, tends to the axial form, since extension into earth and air is necessary to its existence in any advanced condition. There are undoubtedly attractive influences which act to produce this form. The animal tends to the globular form. Its attractions are central, not axial, as in the plant. Its divergences from the globe, therefore, do not arise from attraction, but from pressure, and from the necessity of conformity to other exterior conditions. In the

plant the energy of the poles predominates. In the animal the energy of the centre is most vigorous. The attractions of the one are axial, those of the other central. If only attraction acted upon them the one would be a cylinder, the other a globe. But there are numerous other forces, which produce various divergences from their typical forms.

The foregoing considerations lead us to one general conclusion as to the organisation of matter, namely, that the three visible states of matter—the solid, the liquid, and the gas—are the only states, the action of force tending to the necessary production of one or the other of these states. The gaseous is the disintegrated state. It is the condition of individuality of concrete units. These, in their internal organisation, may possess the liquid or the solid constitution. Externally they have a free field of movement, and vigorous mass motion enabling them to occupy the field. The particles of the free matter of space, and the molecules of the atmospheres of the suns and planets, are in this condition, subject to attraction, but not definitely controlled by it, the only effective controlling influence upon their motion being that of impact.

These units, in their internal organisation, may be in the liquid state of aggregation, though it is more probable that the chemical molecules assume the solid state. The spheres as wholes also display the liquid phase of aggregation, that of rotation about an axis of attraction, with a condensation of their material around the centre of this axis. Solar systems, as units, are also in the liquid state internally, that of rotation around a centre. Each planet represents an annular ring rotating around a centre. In most of the planets this ring has broken up, and its material gathered into one mass. This breaking up and re-aggregation is only partly accomplished in the case of the planetary ring between Mars and Jupiter. In the inner satellites of Saturn the rings remain complete, yielding a condition possibly similar to that which may exist in the organisation of the primary atoms of matter.

But if we consider the solar systems as units in their exterior relations, it is possible that we may have an instance of the gaseous organisation. For, as argued in my article on "The Evolution of the Spheres," they may possess an inter-relation of organisation, but may exist as free moving individuals, precisely analogous to the unit components of a gas. Like the latter, they are subject to attractive and repulsive agencies, dependent upon the directions of their motions. But these are perhaps not sufficiently vigorous to

force them into closed circles of rotation, so that impact may act as one of the controlling agencies upon their direction of motion. In the article mentioned the rarefying effect of such impact was considered. A similar influence, in a minor degree, may affect atoms and molecules when they come into collision, or when they feel the influence of mutual repulsion, their motion through space becoming temporarily converted into internal vibrations of their component particles, or a widening of their radius of internal motion.

The liquid organisation being thus possibly a rotation about an axis of attraction, the question arises—What is the exact condition of the solid organisation? We have argued that solids might arise directly from gases, if these latter were perfectly homogeneous. Such a homogeneous condition may exist in liquids. Their particles having a fixed vigour of movement, the centripetal energy arising from this momentum may be equal at every centre of organisation, so that all of the minute globes may be of one fixed size. In such a case the liquid would be homogeneous, and every particle between and equally distant from the centres of two such globes would necessarily vibrate in a straight line, as though it were attached to the middle of an elastic cord joining these centres. If then, through loss of heat, these centres closely approached, there might in this way be an insensible change from the liquid to the solid state.

But in the solid another mode of action of attractive energy is at work. Despite the fact that the attractions of a mass of particles converge and act from a general centre, the individual attraction between contiguous particles persists. While aiding the general force, it continues to act as an individual force. In the formation of a globe of liquid matter it is not alone the circling motions of the molecules which yield the attraction. A more vigorous force comes from the interior motions of the molecules. These, being in accordant directions, converge, not to an axis, but to a centre of attraction, and are probably far more vigorous than those of the circles of rotating motion. These latter possess a degree of centrifugal force, while the attractions of the individual molecules are wholly centripetal.

But there is a degree of opposition between the local and the general exercise of molecular attraction. Every molecule is attracted in opposite directions by those immediately surrounding it, and tends to vibrate between these opposite attractions. There is thus a struggle between the local and the general attractions. In response to the one, the molecule seeks to rotate; in response to the other, to vibrate.

The vibrating energy has the advantage, in the case above referred to, of particles intermediate between two centres of attraction. It also grows rapidly in vigour as condensation ensues through loss of temperature, attraction increasing in the rapid ratio of the reverse square of distance. Thus a certain degree of propinquity may give the local energy a greater force than that of the combined central energy. The tendency to vibrate between contiguous particles becomes in excess of the tendency to rotate around a general centre of force. Yet the mass is organised in the spherical mode of motion, and a considerable excess of the opposite tendency is necessary to overcome this organisation, unless the liquid be disturbed. If it be disturbed the particles at once break loose from their allegiance to the centre, and begin to vibrate in allegiance to the local energies. The liquid becomes the solid.

But the attractions of molecules are not equal in all directions. If they are rigid, or solid aggregations of atoms, their attractive energy must be strongest in the direction of greatest accordance of motion, weakest in the direction of least accordance. Thus the molecule which vibrates under the influence of several surrounding molecules may feel attractions of diverse vigour in different directions, and may thus be able to move through a wider field in some directions than in others. The molecules have a double influence upon each other. They force each other to assume similar polar directions, precisely as a mass of minute magnets might do. Their poles being thus all in one direction, their greatest vigour of attraction would be in one fixed direction, their least in another. The field occupied by the vibrating molecule must be governed by the condition of the internal motions of the molecules, and the consequent vigour of their attractions in various directions. It might be equal in every direction, or it might have three or more poles of force differing in vigour. And every molecule, while under the influence of a series of surrounding molecules, would form a member of several new series, influencing the motion of other molecules. Thus each molecule would be surrounded by others occupying the angles of some geometrical figure, and its resultant field of action must be an angular instead of a curvilinear space. In short, from such a mode of aggregation, the angular formation of the crystal must result, its shape being fixed for every kind of molecules, since each kind has its peculiar relations of attractive energy.

In very complex molecules, of weak attractive adhesion, the central may again overcome the local energies. These

molecules may have the liquid instead of the crystalline condition. Their mass formations may thus take place in the liquid mode, yielding the colloid, which replaces the crystal in the aggregations of such complex molecules.

II. THE FUTURE "MARTYRDOM OF SCIENCE."

By Frank Fernseed.

IT is commonly, and perhaps too readily, taken for granted that the position of Science and of her followers will be higher and safer in the future than it has been in the past. Those influences and organisations which have oppressed her are, it is supposed, decaying, whilst those which have been her fellow-sufferers, and which have applauded her revelations, are rising into power in their stead.

The other day I saw on a posting-bill these strange words:—"Christianity at the Bar of Science!" "How?" I said, "are Galileo and Bruno about to sit in judgment upon the cardinals, thus reproducing an old error in an inverted form?" But on what authority or on what grounds is it assumed that Science will, in days to come, possess any jurisdiction, legitimate or illegitimate?

In an article which appeared in these pages in March, 1880, it was shown that the former persecutions of discoverers have sprung not alone from clerical ill-will, and a prediction is even hazarded that in future the work once carried on by Caccini and Scioppius will be taken up by very different hands. In other words, scientific research will be denounced and opposed by the leaders of "advanced thought," theological,—anti-theological rather,—philanthropic, social, and political!

This foreboding may at first sight appear paradoxical, and even absurd. Does not the "advanced thought" in question loudly proclaim universal toleration, right of private judgment, liberty of speech? Doubtless; in the days of the first French Revolution it did likewise, till all these brave words ripened into the utterance "The Republic has no need of chemists," and till the achievements and the

reputation of Lavoisier, of Bailley, and Condorcet had no power to save them from looking through the "national window." How do men, certainly not under the sway of what is commonly called religious bigotry, speak even now of Science? "The time is near at hand," says the President of a provincial Literary and Philosophical Society, "if we may judge our age by its tendencies, when the pursuit of Science will have to justify itself anew to the reason of mankind!" According to this authority, then, Science is to take the place not of a free agent, much less that of a judge, but of a prisoner. Her place is to be not on the bench, but, as of old, at the bar.

In a work lately reviewed in the "Journal of Science" (November, 1880, p. 725) we are told by a writer utterly free from any theological bias that "the life that is wholly given over to such pursuits (*i.e.*, research) is a misspent one, and is, as an example, positively injurious to society." What more was ever said by the Holy Inquisition? It is generally considered to be within the competence, and even the duty, of governments to repress whatsoever is "injurious to society," and if, therefore, men holding views similar to those of the writer just quoted should ever come into power, may we not expect interference with research?

Mr. E. R. Russell, in an essay on Trevelyan's "Life of Macaulay," about two years ago, declared "He (*i.e.*, Macaulay) never thought it worth while to quit more attractive studies for the blind and groping physicism which now almost monopolises the name of Science. Whatever good it may have done in other directions, physical science has of late discouraged and debilitated moral and historical inquiry, which is of much more value to the world." Here, therefore, we again find the charge that Science is in some respects hurtful to Society. Are, then, proposals for its repression likely to be very far distant? An eminent author who has recently passed away from among us asked scornfully "whether the heavens were made for Herschell telescopes to shoot Science at?" Even Comte, in many passages of the "Philosophie Positive" (*e.g.*, iv., p. 605), speaks with very little respect, or even toleration, for the scientific specialist. Nor must we here lose sight of the anti-vivisection agitation, a movement largely supported by our "advanced" historians, novelists, and free-thinking writers, and which has been carried to the length of the destruction of the Physiological Institute of the University of Leipzig. Thus we see that varied voices are now raised against Science, certainly not in obedience to any theological or religious

inspiration. Nay, she is even denounced as willing to enter into a concordat with Religion!

Let us look at the subject from another side. What first led the fathers of the Church to turn an unfavourable eye upon natural science? They considered themselves—whether rightly or wrongly is not here the question—entitled to the spiritual guidance of mankind. They were, in their own undeniably sincere belief, the depositories, guardians, and promulgators of truths of transcendent importance to the destinies of mankind.* We can well understand how, filled with such notions, they must regard the teachers of any other doctrines with mistrust and jealousy. However true might be the tenets of the "philosophers," they were looked on by the Church as mere trifling, calculated at the best to withdraw men's minds from their eternal interests. Even, therefore, where no positive contradiction could be traced between Science and Revelation, a feud was inevitable, in which the more powerful party considered itself to be merely suppressing something "injurious to society."

If we now contrast the position of the early Church with that of our "advanced thinkers" of the present day, we shall discern a considerable degree of analogy. The same advanced thinkers—rightly or wrongly it here matters not—conceive that they are the custodians and champions of certain principles for which they wish at all hazards to secure predominance. They have "reforms," possibly revolutions, to effect, and they are angry at every one who refuses to give them his attention,—angrier still and jealous of every man who seeks to engage the public mind with other, and in their opinion comparatively unimportant, subjects. Ebenezer Elliott, the "Corn-Law Rhymer," takes occasion to denounce bitterly the working-class naturalist, who spends his leisure in the woods, studying the habits of insects, instead of taking part in public meetings and reading political organs. The agitator of to-day, like the saint of old, brooks neutrality even less than opposition. Those who are not with him he thinks against him; those who will not be his brothers he must kill! All the time, energy, attention, wealth, expended in research into the secrets of Nature, he views as not merely wasted, but as something stolen from his "movements." Hence he has the same general diffused ill-will to Science which was felt by the Church in the earlier part of her career.

* The reader may consult WHEWELL, Philosophy of the Inductive Sciences, ii., 151 and 153, and History of the Inductive Sciences, i., 267 and 423; ENNEMOSER, History of Magic, i., 355; QUINET, Ultramontanism, 52, 58, 71.

Again, the two powers which were brought in presence of each other in the first centuries of Christianity regarded the world from respectively different points of view. The "philosophers" aimed at tracing facts to physical causes, and, in as far as they had succeeded in arriving at definite knowledge, they saw in all phenomena the working of unvarying law. The fathers of the Church, on the contrary, sought everywhere for moral causes. In all that is they saw or supposed to see personality, will, purpose, arbitrary and even inconsequent. Whether these two opposite views might not ultimately admit of reconciliation neither saint nor sage cared heedfully to ask, and the elements of a "very pretty quarrel" were therefore near at hand. This fundamental opposition between the philosophic and the religious conceptions of the universe has often been set forth, and is noted here solely by reason of its parallelism with another antagonism which is springing up in our days. Till very lately none of the branches of natural science, nor, it might be said, the general spirit and method of science, seemed to approach the territory which the self-styled advanced thinkers in philanthropy, in social reform, and in statecraft claim as their own. Man, whether as an individual or as a member of a community, was openly, or at least tacitly, excluded from the "kingdom of Nature." The differences between man and man were, and still are, traced exclusively to education, to position in life, and to other outward post-natal circumstances, or else to the different action of the free-will of each individual. The distinctions between nations, with perhaps some little reference to the climate, the soil, the productions, and the geographical position of their countries —conceded very grudgingly—were and still are accounted for by laws and institutions. Society was considered as a something modifiable almost at will by the educator and the statesman. Till lately these views reigned uncontested; but modern science, especially since the great reform in Natural History, has restored man to his place in the "kingdom of Nature," just as the astronomical reform of Galileo and his contemporaries "restored earth to her place in the heavens." Anthropology, psychology are now brought into intimate relations with biology, and sociology itself—if such a discipline can really be constituted—will be studied with reference to the organisations existing among the lower animals. Is it probable that such a change in point of view can fail to lead to inferences novel, and therefore unwelcome? Is it likely that the moralists, the historians, the orators, and the metaphysicians will listen patiently to so new and strange a

voice? Will not they take umbrage at the very same reference to physical causes which so offended the fathers of the Church in the first centuries of our era?

Thus I come to the third and final point—the actual conflict of doctrines. Reverting for a single illustration to the old feud between Science and the Church, it will not be forgotten that the "philosophers" held the earth to be one out of a number of kindred worlds revolving around a mighty luminary, the sun, and as being a mere speck in a universe practically infinite. The Church, on the other hand, viewed our globe as the largest and the sole inhabited and habitable body in creation,—as fixed immovably in the centre, whilst the sun and stars revolved around her to give her light and to mark out the seasons. It is not for me to say whether these views are really taught by the Scriptures or not. What concerns us is merely that the Church considered the geocentric theory of the universe as part and parcel of the Christian revelation, and pronounced every antagonistic teaching heretical. Such being the case, we look round and find contradictions equally flat between the teachings of modern Science and the creed of our "advanced thinkers."

It is well known that brutes transmit to their offspring not merely what are called generic and specific characters, but those attributes which distinguish individuals of any given species from each other. Among those domestic animals which have been most carefully observed, we find that not merely colour, size, peculiarities of make, but speed, endurance, and temper go from sire or dam to their descendants. So well is this known that to expect anything else would be looked on as highly ridiculous. Take the colt of a pair of ordinary hacks—would any amount of training ensure it a "place" at the Derby or the St. Leger? The horses which win cups, or those which bear heavy riders across country in the hunting-field or in battle, are members of an equine aristocracy.

We have been much more slow to perceive that the same law applies to our own species. But, thanks to the careful and systematic researches of Mr. Galton, the facts of human heredity are now placed upon a safe base. It is fully proved that stature, complexion, strength, longevity, tendency to certain diseases, eminent mental gifts, peculiarities of moral character, and even little oddities and eccentricities "run in families." The cavil that such resemblances are due to training, imitation, or post-natal circumstances whatever, is so abundantly refuted that it is no longer worth a

serious consideration. Just as there are family peculiarities reaching down through many generations, so there are in every moderately unmixed nation racial peculiarities which may be traced for centuries, which follow a people from barbarism to civilization, and which survive changes of law and government and all those varied agencies to which rhetoricians are fond of ascribing national character. What training or what institutions, for instance, would ever enable a normal Teuton to lie with the readiness, the skill, and the predilection of the normal Slav?

But this very law of heredity, tacitly admitted by every breeder or trainer of domestic animals, and proved as clearly as is any law of organic nature, is not merely denied by the "advanced thinkers," *i.e.*, Buckle, but excites a John Stuart Mill to something bordering upon fury. Why is this? If we examine the inferences which may possibly be drawn therefrom, we shall see that they, to appearance at least, clash with certain principles which the "advanced thinkers" uphold, and which they seek to embody in the form of laws and social arrangements. I hasten to say that I have no wish to decide whether this contradiction is real or only seeming, and whether the differences referred to may or may not be ultimately harmonized. One of these principles is "equality." "All men are born equal," says the Revolution, "and one man is as good as another." "All men are not born equal," replies biological science. It may, indeed, be urged that the equality contended for is merely one of social rights and privileges, and does not involve an equality of being. Is it always practicable to define these two kinds of equality so as to draw a definite line between them? And if our "advanced thinkers" claim for all men merely an equality of legal rights why are they so angry at the doctrine of heredity?

Again, it is contended by a certain school of writers and speakers, following more or less thoroughly in the footseps of Helvetius, that the difference between the genius, the man of mere average faculties, and the fool, is simply one of education. This dream was long ago condemned in the old adage "poeta nascitur, non fit." We now know that education and discipline at home and at school can do very great things with and for the average man, but can effect little for the highest and the lowest order of minds. The genius can dispense with it, and upon the dolt it is to a great extent thrown away. In virtue of the law of heredity science denies universal educability.

A third point of collision is the treatment of crime. If

there is any truth in the doctrine of heredity criminals reproduce criminals. Without wishing to deny that a normal man may, under the pressure of circumstances or from the influence of sudden temptation, commit some casual offence against property or even against the person, we must remember that the systematic habitual criminal, who formally prepares and equips himself for war against society, is the descendant of a line of similar characters who annoyed our forefathers, and that if permitted he will become the progenitor of a race of nuisances to scourge the public in times to come. What is the probability of reclaiming such a being? By what sign are we to know that he is reclaimed? If he is submissive in prison and listens decorously to the monitions of the chaplain is he not "simply biding his time?" Hence the doctrine of heredity involves corollaries little in favour of that indiscriminate leniency in the treatment of crime which has been substituted for an equally indiscriminate rigour, and which our humanitarians wish to extend even to the length of allowing the paltry fines for ruffianism—licences after the fact—to be paid for by instalments. Justice writing up over her doors "weekly payments taken! Thus we see that the law of heredity seems to clash with no fewer than three of the favourite dogmas of our social reformers as decidedly as did the Copernican astronomy with that geocentric system which the Church had taken under its protection. Is it likely that this collision will be unseen, or if seen that it will be accepted with indifference?

We may go further; one of the latest and most interesting results of scientific research, especially into living existence, is recalled to the mind by the much-ridiculed term differentiation. It has been found that in proportion as any being advances in development its former homogeneous structure becomes resolved into parts mutually unlike and subserving different offices and yet harmoniously linked together for the preservation of the whole. We see further that what is thus met with in the growth of the plant or animal from a seed or a germ to full maturity, is repeated in the growth of human society from savagery to civilization.

It may be asked how can this truth come in collision with the creeds of social reformers? In reply I point out that a distinction is now menaced which has become more marked as civilization advances and as the division of labour is felt to be a necessity. I refer of course to the so-called "woman's-rights movement, the

aim of which is substantially to identify the functions of the two sexes, or if possible even to reverse them.

Again, Science teaches us that the species is of more importance than the individual. She shows us that nature in seeking to advance the type sacrifices—if there is any truth in the doctrine of natural selection—millions of its components. She bids us mark how animals of varied grades can throw off a mutilated limb to preserve the body to which it belongs.

Yet our "advanced thinkers" seem to hold that the rights and interests, even the whims of the individual, however temporary, transcend the claims of the community. Nay, a heterodox and anti-vivisectionist writer has even stated, as the characteristic of his school, that it considers the claims of the individual as paramount.

We need scarcely seek for more instances to prove the position taken that certain scientific teachings do not accord with the principles of the "advanced" social thinkers. We see that just as in the old antagonism between Science and the Church there is here jealousy, a generally different point of view and specific doctrines hard—even if possible—to reconcile. Why should this discord be unattended with results similar to those recorded in the middle ages? I do not mean to say that men of science are in any danger of the scaffold or the stake, though they may, as in Leipzig, be exposed to popular violence. Modern persecution has other methods of crushing its victims.

III. THE PHOTOPHONE.

By J. Munro, C.E.

THE last five years have given to the world three extraordinary inventions, the telephone, the phonograph, and the microphone. They are all concerned with sound, and are in reality aids to our powers of hearing. The telephone enables us to hear sounds, especially the human voice, at a great distance; the phonograph permits us to record speech directly without the use of letters, and to reproduce the original words; and by the microphone we can magnify minute sonorous tremors till they come within the range of our hearing. Moreover, they are not only allied in

their uses but in their origin, for the phonograph was suggested by the telephone, and the microphone could not have been discovered had the telephone not been first invented. To these three marvellous instruments we have now to add a fourth, which in a still more striking manner is the offspring of the telephone. This is the photophone or "light sounder" of Professor Graham Bell and Mr. Summer Tainter.

In the speaking telephone, as is well known, the sound waves of the human voice are caused to strike upon a thin diaphragm and set it into sympathetic vibration. This vibration also acts upon an electric current, so as to vary the strength of it in a manner corresponding to the sound waves of the voice; and by leading this current along a telegraph wire and then by reversing the process so as to make it set a second diaphragm into audible vibration, we are able to transmit speech to a distant place by wire. There the electric current is simply the swift medium for conveying the sound from one place to the other, and it does so in virtue of the undulatory character impressed upon it. We might reasonably ask, then, if nothing else will do instead. A ray of light travels through the air with still greater velocity than an electric current along a wire. Are there no means whereby an undulating beam of light can carry sound? Professor Bell has shown us that there is, and taught the "golden silence" of the sunshine to laugh and sing and speak.

The suggestion of the Photophone occurred to Professor Bell in the winter of 1878 when he was lecturing at the Royal Institution. There is a substance named selenium, which is peculiarly sensitive to light, for when a ray of light falls on it an electric current will more easily flow through it than when it is kept wholly in the dark. If then, we make the current to flow at the same time through a telephone, the impact of the ray of light on the selenium will cause such an increase of the current as will be audible in the telephone. Again, the cutting off the light will so diminish the current as to sound the telephone, and thus, as Professor Bell remarked, it will be possible

> "To hear a shadow fall
> Athwart the stillness."

Moreover, the stronger is the ray of light the less is the resistance which it offers to the current; and hence it follows that an undulating beam of light will set up corresponding undulations in the current, and these in turn will generate vibrations in the telephone which may be heard aloud.

Obviously, therefore, if we could devise an apparatus by which the sound waves of the voice could undulate a beam of light in sympathy with themselves, and project this beam to a distant place where it could be received on a piece of selenium through which a current flowed on its way through a telephone, we should be able to reproduce the original voice in the receiving telephone. As early as the summer of 1878 this idea occurred to one " L. F. W.," for in a letter to " Nature" dated Kew, June 3, he describes an arrangement of this kind. Such hints, moreover, interesting in an historical sense, are, however, of very little account in science unless they are followed up by experiment and practically tested. " L. F. W." appears to have contented himself with throwing out the suggestion, and to Professor Bell belongs the honour of inventing the photophone by dint of patient labour.

At the very beginning of his attempt he encountered serious difficulties. The intractable nature of selenium baffled all his efforts. This ambiguous material, which, like phosphorus and sulphur, is neither metal nor non-metal, was accidentally discovered by Berzelius, the great Swedish chemist, when he was groping for something else—tellurium—and the foundling has proved to be the more important substance of the two, for owing to its singular property of electric sensibility to light it has been chosen from among its humbler brethren and lifted into honour. The property in question was accidentally discovered by Mr. May, an assistant of Mr. Willoughby Smith, the electrical engineer, who had set Mr. May to measure the resistance of a piece of crystalline selenium with a view to employing it in testing submarine cables. Much to his surprise Mr. May found the resistance of the selenium vary in a strange manner when the light fell on it, and fortunately Mr. Willoughby Smith took the matter up and verified the effect, and then published it to the scientific world.

The striking effect was eagerly investigated by a number of scientists, who all agreed in referring it to the action of light, and the yellowish-green rays of the spectrum were found by Professor W. Grylls Adams to be the most potent to produce it. Mr. Robert Sabine demonstrated that there was a real diminution of the internal resistance of the selenium under the influence of light; but Professor Adams also showed that the observed increase of a current flowing through the substance was not entirely due to its loss of resistance but to the actual generation of a current in the selenium. This fact is a very important one, and will, perhaps, find its use hereafter in the transmission of optical

images by electricity. For the purpose of the photophone, however, the diminution of internal resistance under light is the main consideration. Dr. Werner Siemens found the decrease to obey a definite law. It is proportional to the square root of the intensity of illumination, and upon this basis he constructed a "photometer," or measurer of light.

This interesting apparatus is known as the "Selenium Eye." It consists of a hollow ball of blackened wood, formed of two halves which can be opened or shut like the lids of the eye. A little within the ball is placed a glass lens to focus the light which enters by the parted lids upon a sensitive selenium cell no bigger than a wafer, fixed at the back of the ball. From this organ two fine platinum wires lead to a voltaic battery and a delicate galvanometer. The current from the battery flows through the selenium cell and the galvanometer at once, so that when a ray of light falls on the selenium and diminishes its resistance the current increases in strength and the needle of the galvanometer indicates the change upon a graduated scale. The deflection on the scale thus becomes a measure of the diminution of resistance, and hence of the intensity of the ray of light. There is a wonderful, nay fearful, likeness between this curious little instrument and the human eye. The movable eye-lids or shutters are present in both, as well as the crystalline lens, while the selenium cell with the conducting wires, voltaic battery, and galvanometer, are paralleled by the optic nerves and the brain. Moreover, there is another similarity which is fatal to the use of the "selenium eye" as an exact photometer. After exposure to the light repeatedly or for some length of time, the selenium cell loses its sensibility to light, and the galvanometer does not respond so strongly as before. The selenium, in fact, becomes fatigued, and like the living eye requires to rest ere it regains its former power. This tendency to physical fatigue was one great difficulty which Professor Bell had to contend with in adapting selenium to the photophone. Another drawback which he had to overcome was to the variable and uncertain nature of that body. Selenium occurs in two forms, the amorphous or vitreous, and the crystalline or metallic form. In the vitreous condition it is a non-conductor of electricity, in the crystalline state it is a conductor, but it has a fickle way of passing from the crystalline into the amorphous form, so that its resistance is apt to vary in an unexpected manner. Professor Bell found it best to crystallise it by annealing it in a crucible at a temperature of 210° centigrade for 24 hours, and then allowing

it to cool slowly for 60 hours. With conductive selenium thus prepared he constructed his photophonic cell for receiving the transmitted light.

Fig. 1 represents this device, which combines a low resistance of the selenium with a large receptive surface. It consists of a number of round disks or "washers" of brass, about 2 inches in diameter, arranged side by side on axles, T T, but separated from each other by disks of mica of slightly less diameter. These are clamped together in close

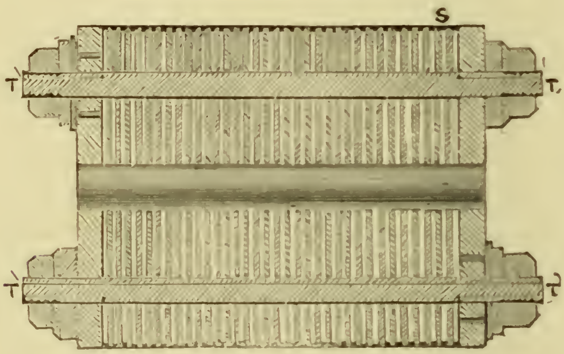

FIG. 1.—The Selenium Receiver.

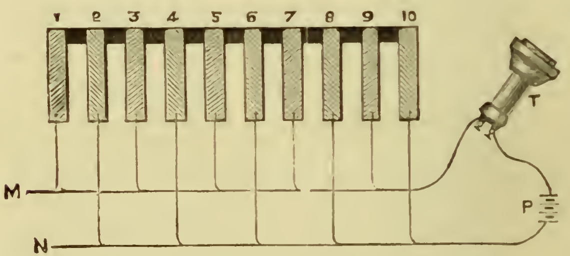

FIG. 2.—DIAGRAM SHOWING THE ACTION OF THE SELENIUM RECEIVER

file, and the grooves formed between the edges of the mica and brass are filled up with melted selenium, S, which is then annealed in the manner described, and the surface of the whole turned smooth in a lathe. The alternate brass disks are connected together, the first to the third and fifth, the second to the fourth and sixth, and so on, in the way shown in Fig. 2 at M and N, so as to give a circuit through the selenium surface, the battery, P, and a receiving telephone, T. A double cell of this construction is then placed

in the focus of a silvered reflector of parabolic contour, and the photophone receiver is complete.

Fig. 3 represents this reflector, C C, with the cell, S, in the focus, and the requisite attachments of battery and telephones. The transmitting apparatus consists of a mirror, M, reflecting a beam of sunlight through a lens, and (if

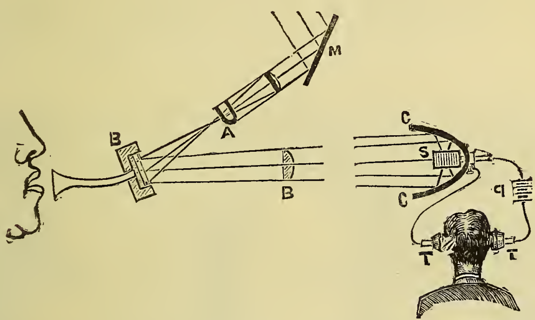

FIG. 3.—Theoretical Diagram of the Articulating Photophone.

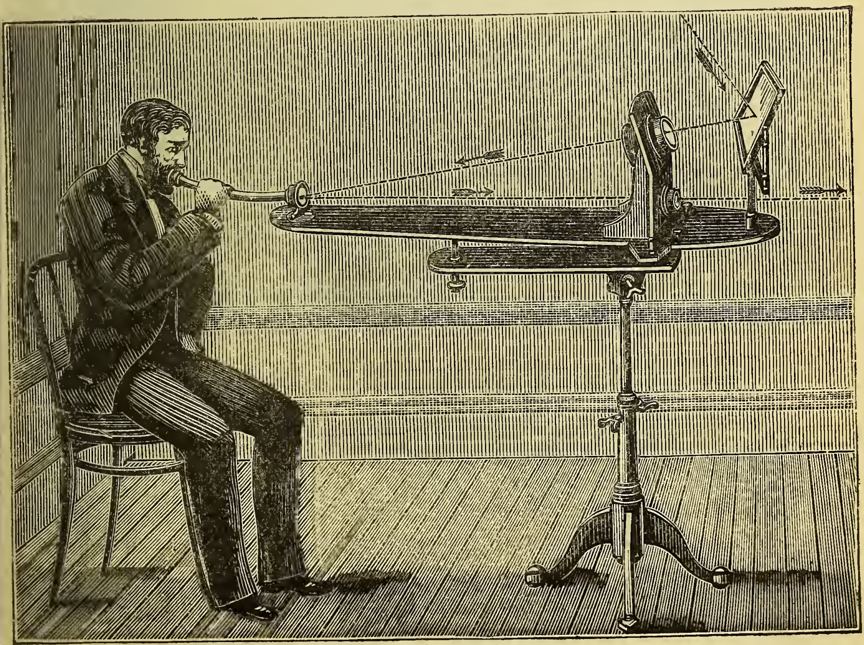

FIG. 4.—The Articulating Photophone. The Transmitter.

for the sake of experiment it is desired to cut off the heat-rays) likewise through a cell (A) of alum water upon the transmitter, B. This is simply a diaphragm of thin flexible glass, silvered on the outside to reflect the light, and fitted into a frame which carries an india-rubber tube and mouth-piece, permitting a person to speak against the back of the glass. A second lens, R, interposed in the path of the beam of light after it is reflected from the mirror, renders the rays parallel, and they travel in that condition until they are focused by the receiver, C C, upon the selenium cell, S.

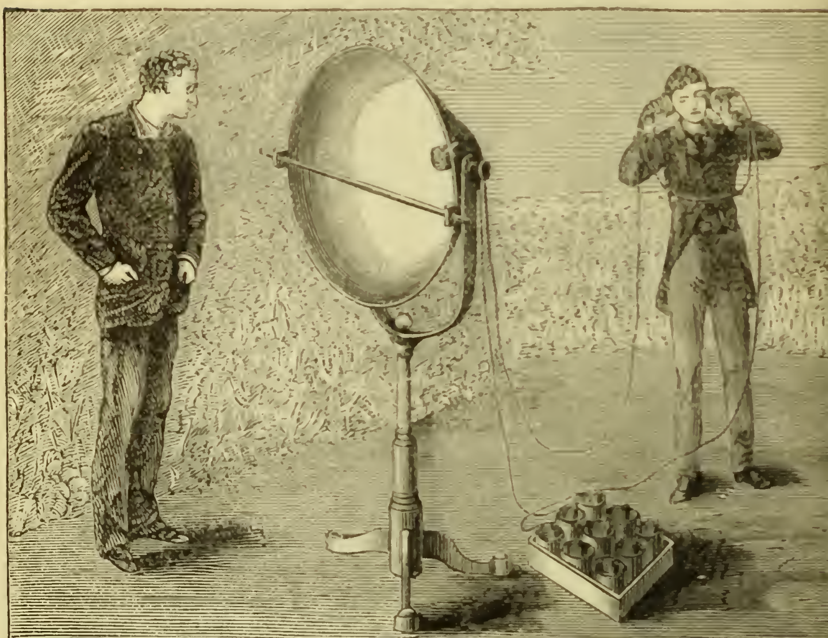

FIG. 5.—The Articulating Photophone. The Selenium Receiver.

In sending the photophonic message the sound-waves of the speaker's voice put the silvered diaphragm into vibration and undulate the beam of light, which on reaching the receiver varies the resistance of the selenium in a sympathetic mode, and reproduces the original voice in the telephones, T T, at the listeners' ears. Figs. 4 and 5 illustrate the operation of the photophone on a larger scale. When sunlight is not available the electric light may be employed, but it requires to be obtained from a very steady lamp, else the

flickering will be audible in the telephone as a crackling sound which tends to drown the voice.

It is obvious that the photophone is the perfection of the heliograph, just as the telephone may be regarded as the perfection of the telegraph. But in each case the crowning instrument has a shorter range than its cruder forerunner. The telephone is dumb on the long wires which readily convey the signals of a telegraphic message, and the photophone would fail to speak over the great distances which are intelligibly bridged by the flashes of the heliograph. Nevertheless it will be possible to photophone for a considerable distance, and even thus early Prof. Bell has succeeded in speaking along a beam of light 830 feet long. His account of the experiment is worth repeating. A transmitting apparatus, similar to that shown in Fig. 4, was placed on the top of the Franklin School-House, at Washington, and a selenium receiver, like that in Fig. 5, was stationed in the window of Prof. Bell's laboratory in L Street, in the same city, 830 feet away. "It was impossible," says the inventor, to converse by word of mouth across that distance; and while I was observing Mr. Tainter on the top of the schoolhouse, almost blinded by the light which was coming in at the window of my laboratory, and vainly trying to understand the gestures he was making to me at that great distance, the thought occurred to me to listen to the telephones connected with the selenium receiver. Mr. Tainter saw me disappear from the window, and at once spoke to the transmitter. I heard him distinctly say, 'Mr. Bell, if you hear what I say come to the window and wave your hat.' It is needless to say with what gusto I obeyed."

This feat proves that the photophone will yet be employed in military tactics, and probably also in correspondence between ships at sea, or perhaps between a shipwrecked vessel and the shore. Moreover, light will penetrate water, and we can even suppose a submarine photophonic talk. The method is of course in its infancy, and will doubtless be perfected in course of time. Already it has realised to some extent the far-reaching truth of the poet, that "light is the voice of the stars." For the changing brightness of the photosphere produced by solar hurricanes has revealed itself to Prof. Bell and M. Janssen in the photophone as feeble echoes, like the murmuring noise due to the flickering of the electric light.

It often happens that in pursuing one line of research a man of science is led into another; and Prof. Bell, in seeking to improve his photophone, arrived at what appears to be a

new discovery of moment. It has long been known that when a bar of iron is rapidly magnetised and demagnetised

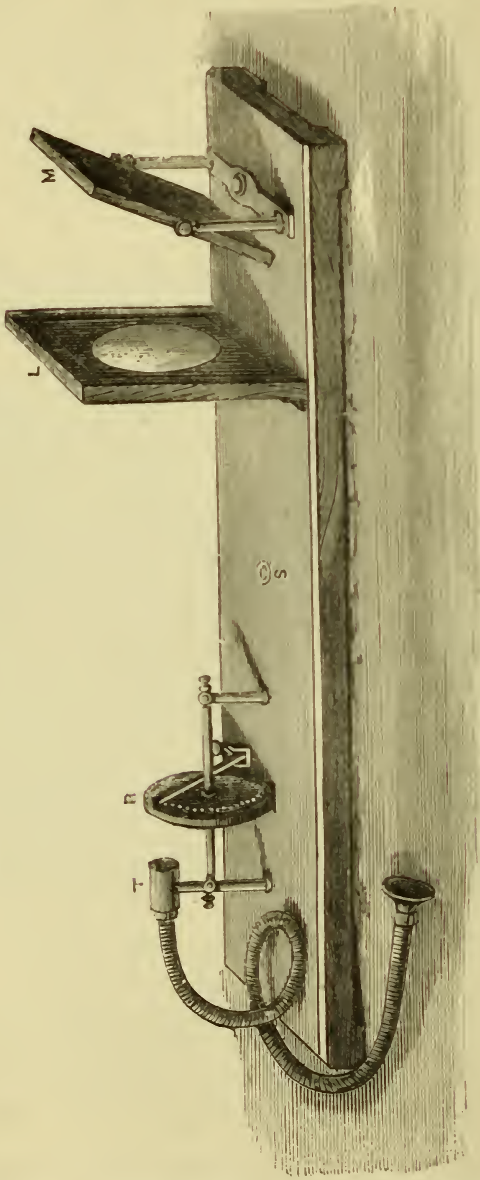

Fig. 6.—The Musical Photophone.

it gives out a musical note of a pitch corresponding to the number of magnetic impulses per minute; and Prof. Bell

found that all kinds of diverse bodies were rendered tuneful by the impact of an intermittent beam of light. Thin disks of wood, glass, metal, ivory, india-rubber, and so on, yielded a very distinct note. The apparatus he devised for these experiments is illustrated in Fig. 6, where M is a mirror reflecting a powerful beam of light from the sun or an electric lamp, through a lens, L, and in the path of the beam is mounted a rotating wheel, R, perforated round the rim with a circle of holes. This wheel acts as a screen to the light, except when one of the holes comes opposite the track of the beam. The latter then passes on to a pair of lenses, T, which direct the parallel beam toward the surface of a thin disk of the material under examination. When the wheel is rotated, the intermitted beam of light falling upon the disk behind causes it to ring with a musical tone whose pitch depends on the number of flashes per minute, and the ear-tube attached enables the listener to hear it without interference. This musical photophone is in reality a light syren, like the air syren of Cagniard de la Tour, in which the puffs of air escaping through the holes of a revolving disk emit a note. The disk form, though advantageous, is not essential to the effect. Crystals of sulphate of copper, chips of pine, even tobacco-smoke held in a glass test-tube before the beam, are found to yield a beautiful tone. Nor is it necessary that there should be light; for if the light-rays be cut off by a thin sheet of hard rubber or vulcanite, the invisible heat-rays which pass through the opaque screen are capable of producing the effect. Indeed it is still a moot point among investigators whether the effect may not be due entirely to the vibratory expansion and contraction of bulk due to the recurring blows of the heat-rays. So distinct is the effect that the naked ear held to the disk appreciates it, and even the outer ear itself acts as receiver, for when the intermittent beam is simply focussed in the aural cavity a faint musical note is heard.

Besides their practical promise, these interesting achievements of Prof. Bell have a poetic bearing. We are at once reminded of that mystical stone of Memnon which the sunshine made harmonious, and can imagine how the chequered sunshine of the trembling leaves is musical to finer ears than ours. In Dean Milman's "Martyr of Antioch" the god Phœbus-Apollo is invoked by the chorus of maidens as—

> "Lord of the speaking lyre
> That with a touch of fire
> Strik'st music which delays the charmed spheres."

And truly the deep connection between light and music is

curiously exemplified in the photophone. Prof. Bell, indeed, has played the part of a god, for has he not inspired a ray of light? Great as his invention is, however, it is probably but the stepping-stone to one still greater which is to come, namely, the transmission of light itself by means of electricity.

For the illustrations to the above article we are indebted to the courtesy of the publisher of the "Engineer."

IV. THE RADIOGRAPH AND ITS USES.

AN important step has just been taken in the difficult science of Meteorology. Before the final goal of prevision could even be conceived of as attainable, it was necessary that all those points which distinguish between season and season, and between climate and climate, should be regularly observed and put on record. In this direction wonderful advances have been made. We note the daily rainfall, the direction and the velocity or pressure of the wind, the degree of atmospheric moisture, and the maximum, minimum, and mean temperature. But as regards this last item, temperature, there was till very lately a great deficiency in our observations, all self-registering thermometers notwithstanding. Suppose that on the 13th of August last a certain temperature was observed. Was this degree of heat due to the action of clear sunshine, or to a current of warm air though the sky was overcast, or to a combination of the two agencies? It will easily be seen that this question is of moment, since the two kinds of heat differ in their action upon vegetable and animal life. Thus bright sunshine is necessary for developing the flavour of fruits and the aroma of flowers, and for ripening the grain, whilst warm air, unaccompanied by direct sunlight, is desired for the germination of seeds and the earlier growth of plants. Hence if our meteorology is to explain why certain crops succeed better in one summer than in another, and in France or America better than in England, it must be prepared to show which of these two sources of heat plays in such season or country the more prominent part.

It will be seen that, in registering the amount of direct solar action at any place, there are two variable quantities to be regarded whose product yields the total sought. There

is duration of action, *i.e.*, the number of hours during which the sun actually shines. This quantity is given by the length of the day *less* such time as it is obscured by cloud or fog.

The second quality is intensity. Everyone must have noticed that the efficacy of the sun's rays is very much greater in the middle of the day than in the early morning or late evening, and also greater when the sky is clear and the air transparent than when the one or the other is dimmed with haze or smoke.

Instruments are already in existence which register one of these factors without the other, and consequently give an imperfect answer to the question. Thus there is the so-called vacuum solar radiation thermometer which is in action in some meteorological observatories. It is a self-registering maximum thermometer with a blackened bulb, enclosed in an outer case of thin glass, exhausted as far as possible of atmospheric air. This instrument shows doubtless the greatest intensity of solar radiation reached, but it gives no sign whatever as to whether this maximum has prevailed for ten minutes or for five hours.

On the other hand, there is an instrument which has obtained a kind of official recognition which records duration without giving any accurate notion of intensity. It consists of a burning glass which concentrates the sun's rays upon a band of paper moved by clockwork at a regular rate. When the sun is shining the paper is burnt to charcoal in a continuous line. As soon as a cloud comes over the sun the action ceases. In consequence of the movement of the paper it is possible to observe during how many hours and minutes this carbonising action has been going on. Whether the sun has shone with just sufficient intensity to scorch the paper, or with twice that intensity, it cannot be made to appear.

As an improvement on this rude contrivance Mr. D. Winstanley, F.R.A.S., lately of Blackpool and of Paris, but now of Richmond, has devised the instrument of which we give a figure.

The instrument consists essentially of a firmly fixed and sensitive balance, carrying a mercurial thermometer, or rather thermoscope, fitted at each end with a glass bulb (T T′) containing air. The former of these bulbs alone is exposed to the sun : A B are balls for adjusting the equilibrium of the balance, and C D are stops which prevent it from tilting too far. When the sun shines on T the air within expands, and drives the mercury to the right along the horizontal

tube, and thus displaces the centre of gravity. In consequence, the right arm descends till the pencil F touches an hour-dial placed below it, and made to revolve by clockwork. So long as the sun shines the pencil remains in contact with

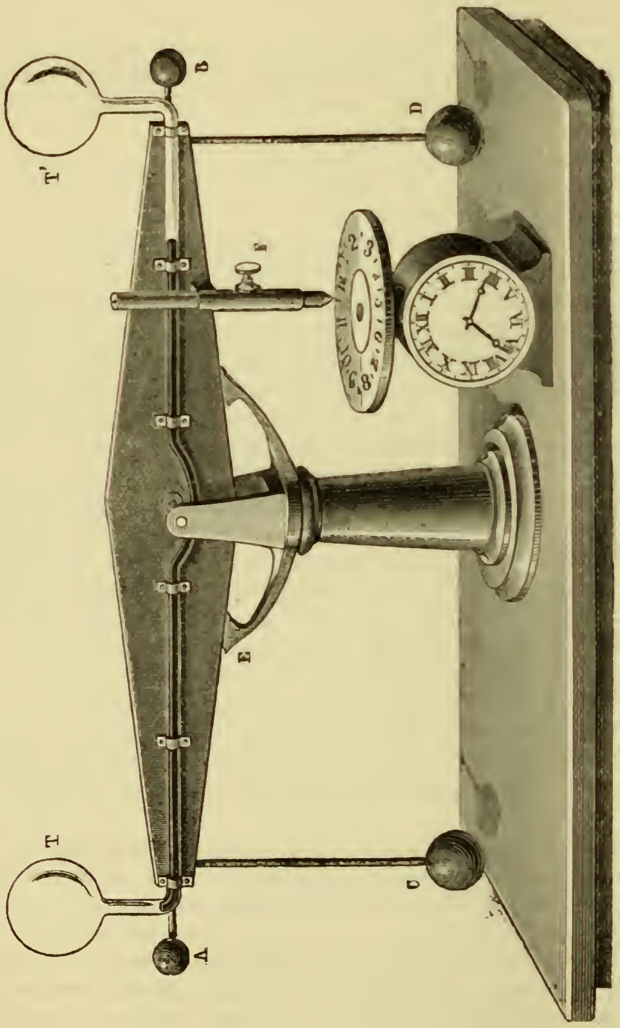

Fig. 1.—Winstanley's Apparatus for recording the Duration of the Sunshine.

the paper on the dial, and leaves a mark as the latter revolves, as shown in the outer line A A A, Fig. 2.

As soon as the sun is overcast the air in T′, acting like a spring, drives the mercury back to the left; the balance

tilts, lifting the pencil up from the paper on the dial, which then continues to revolve without receiving a mark. In the example shown in our figure the sun began to shine a little after 6 a.m., and continued with short intervals till 4.15 p.m. An occultation, even of the length of a minute, was distinctly recorded.

The inventor of this most ingenious contrivance perceived, however, at once, that it was open to the same objection which we have already pointed out, giving duration of solar action, but not of intensity. He therefore went to

FIG. 2.—Facsimile of a Record of the Duration of the Sunshine made by the Apparatus Winstanley.

work again, and devised an apparatus to record both the quantities in a manner which leaves nothing to be wished for.

This instrument, which Mr. Winstanley names the "Radiograph," is shown in the subjoined figure. It consists of a curved tube fixed along the greater part of the circumference of a brass wheel, and carrying at its ends the balls B and A, the former of which is blackened. The wheel turns at its centre on knife-edges of hardened steel resting on agate planes. The lower half of the tube is filled with mercury, and the bulbs are sealed so that the inclosed air cannot escape. The wheel carries a fine steel needle which

plays against a metal drum, made to revolve at regular speed by clockwork, and tightly covered with a piece of glazed paper which has been evenly smoked over at the flame of a tallow candle. As the rays of the sun fall upon B the air enclosed is expanded, and the mercury is driven towards A. In consequence the equilibrium of the wheel is disturbed, and the point of the needle makes a scratch on the fine coating of lamp-black.

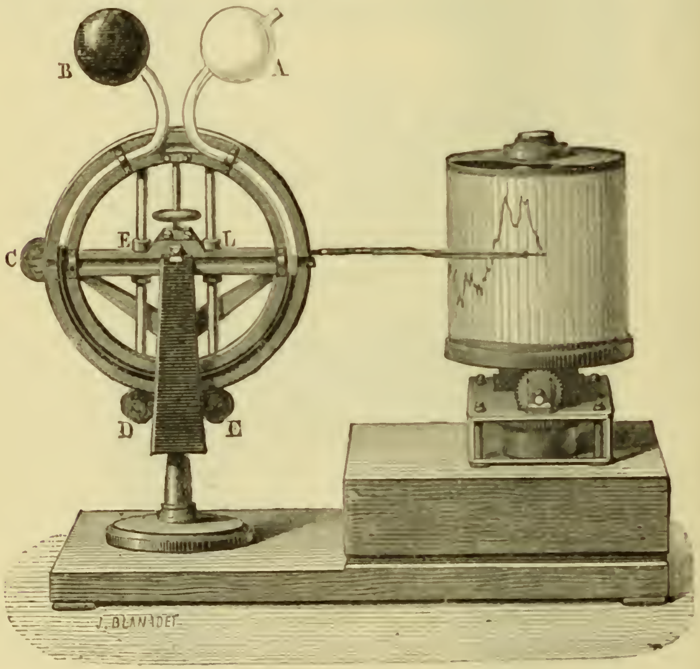

FIG. 3.—Winstanley's Radiograph ; an Instrument which records continuously both the Duration and the Intensity of the Sunshine.

The slightest cloud passing over the sun acts upon the needle, leaving a distinct tracing upon the cylinder, which, in consequence of its rotation, is referred to the exact time at which it took place. Unlike the former instrument, the radiograph leaves an impression during the whole of the day. The feebler the light of the sun the lower is the line, as shown in the accompanying diagram. Here it appears that in the experiment thus recorded the radiation was greatest at noon, and declined then very rapidly for nearly an hour, rising afterwards almost to its former point. The

sudden alternations of sunshine and cloud, many of them of very brief duration, are shown admirably. The tracings

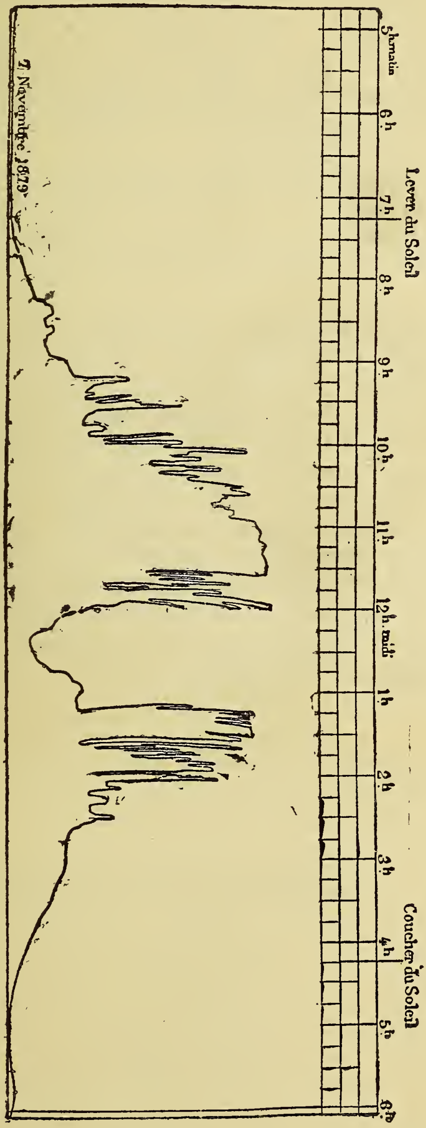

Fig. 4.—Facsimile of a trace made at Douglas, in the Isle of Man, by the Radiograph of Winstanley.

at the end of the day are fixed by means of weak lac varnish, and may then be preserved uninjured.

It must further be observed that the general temperature of the air and the barometric pressure do not affect the instrument, which works solely by the difference of pressure in B and A—a difference due to solar radiation alone. It is scarcely necessary to add the caution that the instrument must not be placed where radiant heat from walls, rocks, &c., which have been heated by the sun, may fall upon B. The radiograph is enclosed in a copper case, out of the top of which the bulbs project, and are protected against rain, &c., by a bell of thin glass.

It is remarked that the instrument gives slight signs of activity even before sunrise, and that the needle rises above what may be called the zero-line at midnight. This takes place with such regularity that it cannot be ascribed to accident.

It may be objected that the radiograph apparently indicates perpetual sunshine. We must, however, remember that even during the passage of the darkest clouds, the sun, though invisible, has a somewhat greater action than when he is below the horizon. We can often feel his rays when we cannot point out his exact position in the sky.

We must pronounce the radiograph a most important addition to the working resources of the meteorologist. It will certainly prove of great value in a comparative study of the intensity of solar radiation at different latitudes and altitudes, as well as in different states of the atmosphere. We trust the invention will be adopted without delay in meteorological observatories.

ANALYSES OF BOOKS.

Lorenz Oken ; a Biographical Sketch. Being a Memorial Discourse on the Centenary of his Birthday, delivered at the Second General Session of the Fifty-second Congress of "German Naturalists and Physicians" at Baden-Baden, September 20, 1879.* By ALEXANDER ECKER. Stuttgart: E. Schweitzerbart.

So rapid has been the advance of biological science in the latter half of the nineteenth century that, as the author truly remarks, "if we read Oken's 'Philosophy of Nature,' we seem to listen to the language of the remote past as if proceeding from the mouth of some Egyptian priest." Still, though the stream of time has swept over the discoveries and controversies of eighty years ago, —though all, and more than all, that Oken ventured to predict has been fulfilled,—we may be permitted to offer our humble tribute of gratitude to the memory of the man whose writings were to us once what a solitary branch of mulberry might be to a silkworm pining amidst a wilderness of thistles.

The author of the work before us disclaims the intention of furnishing—what we should gladly have seen—a thorough critical examination of Oken's scientific achievements. Still he places before us a faithful summary of the chief points upon which the fame of the great German naturalist must rest. To these subjects we must beg to draw the attention of our readers, referring to the outward features of Oken's life only in as far as may be needful for an understanding of his position.

Lorenz Oken was born, as the son of a poor peasant, in what may almost be called the pre-scientific time of 1779. Thanks to his inflexible will, to his integrity of character, his shining abilities, and the aid of friends who were attracted and secured by the latter attributes, he contrived, amidst many privations, to obtain a learned education, and in 1804 he graduated at the University of Freiburg as Doctor of Medicine. Even before this time he had come forward as an original investigator in biology. In his work on "Generation" (1805) he explains putrefaction as a catagenesis,—a resolution of the organic body into its primitive cells or protozoa, which he curiously enough terms "Infusoria." It may be fairly admitted that in this treatise he anticipated the modern doctrine of the cell, and its part in animal

* Lorenz Oken; eine biographische Skizze, Gedächtnissrede zu dessen hundertjähriger Geburt stags feier gesprochen in der zweiten œffentlichen Sitzung der 52 Versammlung deutschen Naturforscher und Aerzte.

and vegetable life. Whilst lecturing at the University of Gœttingen, where he acted as "Docent" (1805-6), he was engaged with the study of animal development, especially of the formation of the intestinal canal in the embryo of the Mammalia. His results were published in 1806, whilst Wolff's researches were only made known in Germany by Meckel's translation in 1812, and Pander's work did not appear until 1816-17.

Concerning Oken's treatise the late E. E. Von Baer remarked —"Highly as I value Dutrochet's and Cuvier's lessons on the development of the mammals, it appears to me undeniable that Oken's researches have been the turning-point for a more correct understanding of the mammalian egg." Still it must be confessed that he does not take a prominent rank among the observers of novel facts. We do not find him, like Cuvier and Hunter, dissecting every insect, mollusc, or reptile that came into his hands. Nor is he recorded as having, like White, concerned himself with the habits, the migrations, or the local occurrence of species. His strength lay in the detection of parallelisms and analogies; in generalisations and predictions, bold, sometimes successful, but too often rash. For it must be confessed he did not possess the grace of suspending judgment, but rushed to conclusions where it would have been more discreet to await further evidence. Among his forecasts we may cite the following:—"The fundamental material of the organic world is carbon; the carbonaceous mass must be at once solid and liquid, even slimy; everything organic proceeds from slime. The primitive slime from which all things proceed is the sea-slime." Here we have the theory of the Protoplasm and the Bathybius! Our modern authorities, too, speak of organic chemistry as the chemistry of carbon and its compounds. "The first step," says Oken, "from the inorganic to the organic is the conversion into a cellule." "The task of the philosophy of Nature is," he declares," to show how the elements and the heavenly bodies have arisen; how they (the former) have been developed into higher and more manifold types, and have appeared as minerals; becoming finally organic, and ariving at self-consciousness in man." Here, therefore, we have an explicit avowal of Evolutionism, rare in the earlier part of the century. In consequence he was occasionally, in England at least, denounced by the dominant Cuvierian school as a setter-forth of dangerous doctrines. We remember well feeling compelled to address a private letter of remonstrance to the editor of the "*Zoologist*" on occasion of a review of Oken's "Philosophy of Nature" (the Ray Society's translation) which appeared in that valuable journal.

Among Oken's other merits must be mentioned his earnest endeavours for the introduction of the natural sciences into the ordinary educational curriculum in Bavaria, and his controversy with Thiersh, the advocate of the word-mongers. Closely herewith connected was his laudable endeavour to minimise the pro-

portion of Greek and Latin words in scientific terminology. We can fancy the expression of his face if he had ever encountered such terms as "arctiodactyls" and "perissodactyls."

He also deserves, and is beginning to receive, due honour as the founder of the "Congress of German Naturalists and Physicians,' of which the British Association is a copy.

We cannot conclude this brief notice of Herr Ecker's interesting work without reference to one of Oken's greatest discoveries, which involved him in a dispute as to priority with the poet Goethe, and undoubtedly exercised a great and outwardly unfavourable influence upon his career. On entering upon his professorship at Jena (July 30, 1807) he published a small work which bears the title "The Signification of the Skull-Bones," and which gave a new direction to the doctrine of the morphology of the skeleton, by pointing out the homology between the skull and the vertebral column. It is evident that he had long entertained this idea, since as early as 1802 he had pronounced the organs of sensation to be merely a repetition of lower organs. In August, 1806, when taking a tour in the Harz in company with two students, he found by the Ilsenstein the bleached skull of a deer, and was at once struck with the analogy in question. He sent his work to Goethe, the "curator" of the University of Jena, and he writes—"This discovery pleased Goethe so that he invited me, in the Easter recess, 1808, to pay him a week's visit in Weimar, which I did." Nothing is known as to what passed at this interview, and it is remarkable, as Herr Ecker points out, that "Goethe, to my knowledge at least, never mentions Oken, though he otherwise followed with great interest much less important researches which bordered upon his own studies." Sixteen years after this interview, in 1824, Goethe laid claim to the priority of the discovery in his "Contributions to Morphology." He asserts that in 1791 he found the skull of a sheep on the Lido, at Venice, and was struck with the analogy. He adds, still without any mention of Oken, that "in 1807 this theory had been given to the public tumultuously and incompletely." The flatterers of the great poet have actually gone so far as to accuse Oken of having stolen the idea from Goethe—a charge for which there is not the slightest foundation. The two men never met until after the publication of Oken's work. No correspondence had passed between them, and Goethe had certainly not made his discovery public. The priority of publication and demonstration undoubtedly belongs to Oken, and we fear that Goethe, though he made no explicit charges against his co-discoverer, cannot be acquitted of having tacitly sanctioned their propagation by others. Hegel in particular had the indiscretion to say, without the shadow of proof, that Goethe had communicated his ideas to Oken (Hegel's "Werke," vol. vii., sect 1, p. 567; Berlin, 1842).

There was indeed, after the visit in 1808, a coolness between

Goethe and Oken, which the former evinced in a very unworthy manner. Making use of his position in the Weimar Government, he prevented Oken from delivering a course on botany in the Lecture-Hall of the Botanical Gardens at Jena. Worse than this, he took part—as a document quoted by Herr Ecker but too plainly shows—in the intrigues which led to the removal of Oken from his professorship and the suspension of his journal, the well-known "Isis."

We can add no more save an aspiration of "peace to his ashes and glory to his memory," and an expression of thankfulness to Herr Ecker for his able and faithful survey of the life and the struggles of the illustrious biologist.

Is Darwin right? or, the Origin of Man. By WILLIAM DENTON. Wellesley, Mass.: Denton Publishing Co.

THE work before us is one which may fairly claim our attention. The author is most decidedly an evolutionist. He argues ably against the advocates of mechanical creation, and in support of the "natural origin of man" he appeals to the metamorphosis of animals, to anatomical similarity, to linking forms, rudimentary organs, palæontological resemblance, geological succession, insular organic resemblance, the antiquity of our species, and to brutal characteristics. In all these respects, if no absolutely new facts are brought forward, the evidence is summarised with great clearness, and the objections to the theory of development are met in a masterly manner.

Mr. Denton belongs, however, to that—dare we say "increasing"?—party who, whilst fully accepting Evolution, and even recognising "Natural Selection" as a *vera causa*, consider it as insufficient to account for the existence of all organic forms, and especially of man. He has been led by his "investigations in mesmerism, spiritualism, and psychometry" to consider the theories of Darwin and Huxley deficient as ignoring "the spiritual side of the universe, infinitely its most important side." "Natural Selection" he regards as "the gardener that trims the tree of life, lops off the imperfect branches, and destroys the sprouts that might divert its energies, but not the Creator that gave life and form to the tree." Here, though on very different grounds, he will find thoughtful naturalists not a few who will agree with him, and who think the struggle for existence more likely to reduce than to increase the number of organic forms. Mr. Denton differs from the Darwinian school in rejecting haphazard variation as the grand agent in the production of species. He considers that Evolution has followed a plan in which purpose and wisdom are conspicuous. He enumerates certain

"pointers" which indicate that man's origin has been not merely human and brutal, but at the same time spiritual and divine. As such he enumerates the man-ward progress of our planet, the race-development of animals, the phenomena of organic distribution, the persistency of type, the multiplicity of human origin, language, the tendency to beauty, the human faculties, and the spiritual faculties.

Now we are by no means so much in love with "Natural Selection" as to suppose it capable of accounting for all the facts of organic existence, and we are far, very far, from wishing to ignore the considerations which Mr. Denton has brought forward. It may be mental feebleness on our part, but we do not see our way to a purely monistic interpretation of Nature, and we fancy that for those who do, or think they do, the future may have in store a startling revelation.

But we find in the author's arguments much to which we must demur. Thus we find him arguing in favour of spontaneous generation, or *abiogenesis*, as it is now officially called. After giving an account of the experiments of Tyndall, he proceeds:— "The experiments of Wyman, Mantagazzi, Bastian, and a host of others who have found living beings in sealed glass vessels after they had been exposed to a heat much more than sufficient to kill germs if they had existed, can never be negatived by such experiments as Tyndall's, were they multiplied a thousand-fold." Now we should regard it as a most splendid triumph if life could be produced from inorganic matter under circumstances where the intervention of antecedent life was demonstrably impossible. But this is precisely what has not been done. Germs are found capable of bearing temperatures much higher than had been formerly supposed. But if the exposure of heat is sufficiently high, sufficiently prolonged, or often repeated, then no life appears. No experimentalist in this direction has had so much practice as M. Pasteur, and where the precautions which he indicates have been rigorously followed we do not hear of any affirmative result.

Elsewhere we find the existence of "essentially human faculties" adduced in proof of the spiritual origin of man, of his being an approximation to a type of perfection. Says the author:—"Phrenology as taught by Dr. J. R. Buchanan is as much a true science as geology taught by Sir C. Lyell, and can be much more readily demonstrated. This science reveals in man the existence of reverence, modesty, benevolence, chastity, integrity or conscientiousness, &c." Now without pointing to the discrepancy of the results obained by modern cerebral physiologists, *e.g.*, Hitzig and Ferrier, from the doctrines of the phrenologists,—without asking why mental faculties should be located merely in those portions of the grey matter which underlie some portion of the skull accessible and measurable during life,—we may point out that to distinguish, by any clearly-marked

characters, the brain of the mias from that of man is confessedly "the anatomist's difficulty." But if every faculty is located in an especial portion of the brain, and if certain faculties present in man are wanting in the ape, then it follows that certain regions of the brain must be wanting in the latter, and the anatomist could not fail to be struck with the difference. Further, benevolence and even conscientiousness are clearly to be traced in the actions of the higher brutes. Hence we may legitimately look with an eye of suspicion upon an alleged science which takes such grounds.

The spiritual faculties in man—*i.e.*, *clairvoyance*—are next adduced as a gift which cannot be accounted for by the action of Natural Selection. We do not, be it known, presume to refer these phenomena to "DOMINANT IDEAS," but surely they are still too much matter of dispute to be brought forward on such an occasion.

Of much more value are the considerations urged under the head "Persistency of Type." If organic forms are the results of casual variation, weeded out by natural selection, the question may surely be asked why they are confined within so limited a range? It has often been pointed out as unexplained that no vertebrate animal has more than two pairs of limbs. But the author here hazards some remarks which we can scarcely call judicious. He asks, "Among reptiles, why not the first indications, at least of a transformation of the fore feet to wings and the appearance of feathers?" Need we remind him of the pterodactyle and the archæopteryx, both of which he figures in this very work? Again it is said—"Why not some indications of hands to take the place of the hoofed feet of horses and cattle?" Because in that group development has been moving in the very opposite direction, as he himself shows in figures taken from Marsh. "A pair of eyes at the back of the head and a pair of arms to correspond" would involve fundamental alterations in the entire skeleton. Where would the shoulder-blades and the muscles for the extra pair of arms be fixed? Should such ever appear they would scarcely begin with "buds behind the shoulders of some babies." "A telescopic eye" would in most spheres of life be useless, or rather harmful to its possessor.

The remarks on language we cannot accept, and we regret to find him using the worn-out phrase "dumb animals." Brutes have developed languages, and we have no right to term them dumb because such languages are to us unintelligible.

An important idea, which the author presents more than once under varied forms, is this:—"The tree never advances beyond its fruit, and I believe the tree of life fruited when man appeared." If Mr. Denton is herein correct the task of Evolution is ended, and we need not wonder if no new forms can be detected in the act of making their appearance.

We differ from the author on many points, and on others we are doubtful, but whilst the theory of the origin of species is still so far from completion we would listen to every candid contribution that is offered.

United States Commission on Fish and Fisheries. Part VI. Report of the Commissioners for 1878. Washington: Government Printing-Office.

This important and bulky return comprises an inquiry into the decrease of food-fishes, returns on the propagation of such fishes in the waters of the United States, and, in addition, several useful appendices. In noticing this work there is one preliminary reflection which we are unable to suppress: what an immense supply of food—capable, moreover, of great extension—we must be content to abandon if the Vegetarian party should succeed in enforcing their views!

The author of this Report, Spencer F. Baird, justly remarks that "wherever the white man plants his foot, and the so-called civilisation of a country is begun, the inhabitants of the air, the earth, and the water begin to disappear," and he adds that "the cause of this rapid deterioration is not to be found in a reasonable destruction for purposes of food, of material for clothing, or other needs. It is only as the result of wanton destruction for purposes of sport, or for the acquisition of some limited portion only of the animal, that a notable reduction is produced, and the ultimate tendency to extinction is initiated." In confirmation of these views we find statistics proving the fearful decrease of food-fishes in the rivers and the shore-waters of the Eastern States within the last half-century. It will be well for mankind if they can be brought to see how suicidal has been their conduct. Better still if future generations cease to look upon the taking of animal life as an amusement. The difficulties to be encountered in making the ocean supply a fair quota of food for the increasing population of the dry land are very serious. There is wanton or ignorant destruction to be checked; there is the scientific propagation of fish to be elaborated and extended; and there are, in England at least, monopolist middle-men to be hunted down, who have proved deadly enemies alike to the producer and the consumer.

In all these directions there is still much to be done and much to be learnt. The natural-history of many food-fishes is still so imperfectly known that it is by no means certain what times and modes of capture interfere least with the multiplication of these creatures.

As regards pisciculture our knowledge is decidedly in advance

of our practice. We give an instance :—The raising of carp has long been found in North Germany a fairly profitable business. Farms in watery situations are very frequently fitted up with a series of properly arranged ponds for the young fry, for the larger carp, and a wintering-pond. The former are shallow, but for the latter a depth of 8 to 12 feet is required. It is found that in many seasons more money can thus be realised from an acre of fish-pond than from an acre of arable land or pasture ; and it is somewhat strange that our farmers, in their very natural anxiety for profitable means for utilising the soil, have done so little in this direction.

The culture of carp is described very thoroughly in this report. In Upper and Nether Lusatia the production of carp amounts to from 8000 to 10,000 cwts. A single German breeder of gold-fish raises annually 300,000. He employs fifteen labourers, a night-watchman, and a book-keeper, besides the men employed at his sale-rooms in Berlin. All these persons earn a good livelihood, and the profits are considerable.

Passing from these practical facts, it must be noted that the present report contains very valuable contributions to the natural history of the herring, the cod, and certain of the Salmonidæ, especially the Californian salmon.

The liberality of the American Government in supplying not merely valuable information on pisciculture, but in forwarding large supplies of the ova of esteemed food-fishes to New Zealand, Tasmania, &c., deserves the warmest acknowledgment.

A Polar Reconnaissance. Being the Voyage of the *Isbjœrn* to Novaya Zemlya, in 1879. By ALBERT H. MARKHAM, F.R.G.S. (Captain Royal Navy). London : C. Kegan Paul and Co.

CAPTAIN MARKHAM is evidently an enthusiast in the cause of Arctic exploration. The voyage here narrated may be looked upon as a feeler serving to ascertain the most hopeful track for a future Polar Expedition. The author, from his own experience, endorses the view of Sherard Osborne, that, in order to penetrate into the still unknown north, it is necessary to find a coast-line trending northwards with a western aspect. As such he selects the west coast of Franz Josef Land, stretching to the north from 80° lat. He considers it essential, however, that the Expedition should be prepared to spend a winter in the ice, and to send out extensive sledge parties.

The first part of this work contains an account of earlier voyages to the north-east—English, Dutch, Russian, Norwegian, Austrian, and Swedish. The author regrets the comparatively

unimportant part which England has latterly taken in the task of geographical discovery. That such is the case is true. Even within the boundaries of the British Empire, and in regions immediately contiguous, there is very much still unknown, and we, with our unequalled facilities and with the most urgent motives for exertion, are not doing what might fairly be expected. Still we can scarcely sympathise with Capt. Markham's especial predilection for the Polar regions. It seems to us that, for instance, a thorough exploration of New Guinea would be more valuable to Science than the most minute survey of the unknown regions around both poles! The geology of these latter lands is generally masked under snow and ice, and their biological features are very scanty.

The cruise of the *Isbjœrn* was primarily of a sporting character, Sir H. Gore Booth, who invited the author to accompany him, being intent on walrus-shooting on the coasts of Novaya Zemlya. Leaving England by the mail-steamer *Tasso*, for Trondjem, they embarked in the Norwegian mail-boat *Lofoten*, which plies between the latter town and Tromsö. Here difficulty arose on account of a dog belonging to Sir H. G. Booth, and which, according to the Norwegian protectionist system, was contraband. Though its owner had no intention of landing it on Norwegian soil at all, it could not be taken on board the *Lofoten*, but had to be left at Trondjem until certain formalities had been completed, and was then taken northwards in another steamer, secured by a chain to a bolt in the deck, and with the official seal of the Customs on its collar. We have heard of a yet stranger case:—An Anglo-Norwegian firm, who carry on the manufacture of fish-manure in the Loffoden Islands, sent over a cargo of potatoes for the use of their workmen there. It was found, however, that the roots could not be landed even on payment of duty. The ship's crew had to eat the potatoes on board, and an official came every day to see and to certify that the parings were duly destroyed by fire!

In Novaya Zemlya the travellers found during the brief summer a somewhat luxuriant vegetation, including a beautiful purple saxifrage, a bright yellow poppy, and the forget-me-not. The birds of this hyperborean region are, of course, chiefly sea-fowl. The author states that a couple of glaucous gulls endeavoured to warn a seal which Sir H. G. Booth was quietly approaching with murderous intent, and as it took no heed of their screams they at last alighted on the ice, walked up to the seal, and pecked him, when he at once dived down into the water. Foggy weather, the explorers found, accompanied high winds, whether from the south-west or north-east, and bright clear weather almost invariably ensued in a dead calm. The reindeer in Novaya Zemlya, which are by no means scarce, seem to subsist during the winter on the fat they accumulate during the summer. The common account of their sweeping away the snow in order to

browse upon the plants hidden beneath is questioned by Captain Markham, as the snow is several feet deep, and as all vegetation withers at the end of summer. At the head of Schubert Bay the author captured a few butterflies. The author saw none of these insects on any day save August 4th, and he thinks that their life in the mature condition must be probably less than a week.

Commodore Jansen, of the Dutch navy, suggests the establishment of meteorological stations along the coasts of Lapland and Siberia. Observations taken there would, the author thinks, aid much in deciding when a favourable season for Polar expeditions might be anticipated.

A number of Appendices on the scientific results of the voyage are subjoined. Sir J. D. Hooker reports on the plants; Captain Feildon on the birds, of which twenty-six species were captured and three others identified; E. J. Miers gives an account of the Crustacea; E. A. Smith describes the Mollusca; F. J. Bell, the Echinodermata; H. B. Brady, the Rhizopoda; Mr. Etheridge, the geological collections; R. McLachlan, the insects; and Dr. Günther, the fishes.

The results of the voyage may be pronounced decidedly valuable, especially if we consider its very limited scale and brief duration. The book, in addition to its scientific interest, contains much which cannot fail to gratify the lovers of adventure.

Education. An International Magazine. Bi-monthly. Devoted to Science, Art, Philosophy, Literature, and Education. T. W. Bicknell, Conductor. Vol. I., No. 1. Boston: New England Publishing Company. London: Trübner and Co.

We have here the first number of a new journal, thoughtful, ably conducted, and if breathing a spirit somewhat strange to us not on that account the less interesting. We find, indeed, here and there utterances which somewhat surprise us. Thus we read—"The State has always a means of limiting, if necessary, the number of those who seek a high education, and casting aside those who have not the capacity or the endurance; they may increase the standard of examination for admission and graduation so as to secure that only the highest scholars pass." Unfortunately examination is no test of the originating power, and those "cast aside" may easily happen to be the very best men—the inventors and discoverers.

Another writer quotes a saying of a professor of the John Hopkins University, "that the English people are divided into

two classes, examiners and examined,"—quotes it, too, not in ridicule or in pity for a nation which is thus following the example of China, and deliberately rendering itself incapable of original thought!

An editorial article, on the "Mundella Education Bill," speaks of the "quiet and unobtrusive manner of its introduction into the new educational structure of England's coming greatness." Whilst appreciating the kindly feeling here brought to light, we fear "England's coming greatness" is an exceedingly questionable matter. Perhaps, in consideration of what we once were, the leading powers of the future will permit us to go on passing examinations, making speeches, laying wagers, and founding sects and philanthropic movements.

Elsewhere the editor speaks of "interpreting the whole universe by the nobler key of Plato, Aristotle, and Hegel, rather than by the dog-headed and monkey-tailed ciphers of Darwin and Haeckel!" Such remarks carry with them their own criticism.

Practical Botany for Elementary Students. Introductory to the Systematic Study of Flowering Plants. By D. Houston. (Stewart's Educational Series.) London: W. Stewart and Co. Edinburgh: J. Menzies and Co.

The work before us is of a practical character. The student is told how and what to observe; the instruments needful are described in the introduction, and the plants selected for examination are well known and easily procured types of the fifteen natural orders included in the "Syllabus of the First Stage of Elementary Botany issued by the Science and Art Department." The author believes that no better selection of natural orders, as an introduction to the study of classification, could possibly be made. As one of his order-types the author takes the common buttercup; he directs the examination of its roots, root-stock, aërial stem, leaves, inflorescence, flower, and fruit. Of these parts the flower and fruit are most closely scrutinised, using the lens, and making certain sections. Notes are to be taken and sketches drawn. From the particulars observed the pupil learns why the buttercup is referred to the class Dicotyledons, the division Polypetalæ, the subdivision Thalamifloræ, and the natural order Ranunculaceæ. A list is then given of other well-known plants belonging to the same order, and reference is then made to its general properties and uses, and to its geological and geographical distribution.

It is very evident that the student who has carefully worked

through the fifteen representative plants here described will possess an amount of knowledge such as he could never acquire from books alone, or from the mere cursory and superficial examination of specimens. It is therefore at once a duty and a pleasure to recommend this little volume.

Dimensions of the Fixed Stars. With especial reference to Binaries and Variables of the Algol Type. By EDWARD C. PICKERING. Cambridge (U.S.): J. Wilson and Son.

THE author proposes to give a full trial to the method taken in the case of satellites and small planets,—in other words, to deduce their dimensions from the amount and character of their light. As a result of this method, he gives for the two components of *a Centauri* the respective magnitudes of 1·82 and 0·46 times that of the sun.

As regards variable stars of the Algol type, where a maximum and minimum of brightness succeed each other periodically, the author discusses several theories, and favours the supposition that the variation in light is due to the interposition of a non-luminous satellite.

This memoir is reprinted from the "Proceedings of the American Academy of Arts and Sciences," vol. xvi.

The Journal of the Royal Historical and Archæological Association of Ireland. Vol. V. Fourth Series. No. 41.

THIS number contains an account of a megalithic structure at Mongnacool Lower, County Wicklow, locally known as the Fairy House. No traces of urns have been found, nor is there any appearance as if the ground had been disturbed by treasure-seekers. There is also a notice of a flint knife and an ornamented bronze celt found in the County Tyrone, a region where the manufacture of such implements appears to have been extensively carried on. About five years ago a large collection of bronze arms and tools, all damaged, was found hidden beneath a huge block of stone in Bo Island, in Lower Loch Erne.

Journal and Proceedings of the Royal Society of New South Wales. 1879. Vol. XIII. Sydney: Thomas Richards. London: Trübner and Co.

We cannot express ourselves as well satisfied with the work done by the Society during the year 1879. The Biological Section has given no sign of life; the Geological and Palæontological Section has been merged in that for Chemistry and Mineralogy; and the amalgamated body has held only four meetings, at which nothing of importance took place.

Among the proceedings of the Microscopical Section we note an interesting paper on some recent objectives manufactured by Carl Zeiss, of Zena, communicated by G. D. Hirst; and notes on Tolle's duplex front 1-10th immersion objective, in comparison with Zeiss's oil immersion 1-8th (No. 18) by both oblique and central light, by H. Sharp. The writer considers that the Tolles lens, compared with Powell and Lealand's new formula 1-8th, has greater working distance, is more achromatic, gives superior definition, and in flatness of field is not inferior. "With water-immersion, either by oblique or central light, in resolving power, clearness and brilliancy of definition, and extraordinary penetration, this 1-10th Tolles is unequalled by any water-immersion objective I have yet seen." By oblique light it is somewhat inferior to the Zeiss, but with direct light the latter is quite eclipsed by the Tolles.

Mr. T. E. Hewett describes an improved dissecting microscope, the power being Sir J. Herschel's plano-convex doublet, which has seldom, if ever, been applied to microscopes.

The Royal Society of New South Wales has, curiously enough, a Section for Literature and the Fine Arts, the doings of which fill up no inconsiderable portion of the volume.

The Vice-President, Prof. Smith, C.M.G., in his Anniversary Address, referred to the loss which the Society had sustained by the death of the zealous geologist, Rev. W. B. Carke, the true discoverer of gold in Australia.

Records of the Geological Survey of India. Vol. XIII., Part 4, 1880.

In this issue Mr. W. Theobald describes the Pleistocene deposits of the Northern Punjab, and considers that they afford evidence of an extreme climate, and probably of glaciation, during a portion of that epoch.

Mr. C. A. Hacket gives an account of the useful minerals of the Arvali region. The copper mines of the district appear to

be exhausted; but blue vitriol, alum, and copperas are obtained from the weathered shales and other refuse of the mines. All these products contain traces of nickel and cobalt.

Dr. Feistmantel shows that the unconformity existing in Africa, India, and Victoria, between the Ekka beds, the Talchir beds, and the Bacchus marsh-beds and their underlying rocks, is in New South Wales filled in between the Hawkesbury rocks and the Devonian beds of the series of the Australian coal-beds.

Mr. W. Center and Mr. H. B. Medlicott deal with the important question of the "Reh" or alkaline soils of Upper India, and the saline efflorescence so fatal to agriculture.

Report of the Entomologist of the United States Department of Agriculture for the Year 1879. By J. HENRY COMSTOCK. Washington: Government Printing-Office.

THIS treatise contains an account of a serious catalogue of vermin, all of which claim for their share no small part of the fruits of human industry. Cotton, grain, clover, the orange tree, the vine, the sugar-cane, the potato, the cabbage—all have their special enemies. Fortunately they are to some extent kept under by parasites and foes of their own rank. Hence one of the most important duties of an agricultural entomologist is to warn the public against destroying their allies.

The so-called red-bug of Florida and the West Indies (*Drysdereus suturellus*) is very destructive, both to the cotton and the orange crops. It may possibly be utilised as a dye, since with an alum mordant it dyes woollens and silks a rich orange-yellow.

Geological Survey of Canada. A. R. C. SELWYN, F.R.S., Director. Report of Progress for 1878-79. Montreal: Dawson Brothers.

DURING the season much useful work has been done, though a portion of it, from lack of time, partakes of the character of a preliminary reconnaissance rather than of a minute survey.

Dr. G. M. Dawson reports on the Queen Charlotte Islands, and enters largely into topographical details. It appears that at Anchor Cove an anthracite mine was opened in 1865, but was finally abandoned in 1872. Two distinct epochs of glaciation have been traced in British Columbia, the former of which was

the more intense; its disappearance was accompanied by a subsidence of the land amounting to several thousand feet.

The aborigines of these islands bear the name of Haidas. They possess remarkably fair skins as compared with other Indian tribes. They are rapidly decreasing in number, owing to the introduction of European diseases.

As an Appendix to this report we find a catalogue of the plants and the marine invertebrate animals observed by the explorers.

The next following report treats of the Churchill and Nelson Rivers, and of the region around the God's and the Island Lakes. The surveyor, Dr. R. Bell, has made extensive botanical and zoological collections.

The water of the River Assiniboine, which may possibly be used for the supply of the rising city of Winnipeg, contains much sulphate of magnesia. It is proposed to remove this objectionable ingredient by treatment with wood ashes. "In this way salubrious salt, the sulphate of potash, would be substituted." We strongly doubt whether the continued introduction of sulphate of potash into the system would not prove injurious. The author lays down the northern limits of the commoner forest trees in the country to the east of Hudson's Bay.

The insect-fauna is decidedly boreal in its character, and includes several European species, not forgetting the cosmopolitan *Cynthia Cardui*. No lamellicorn beetle is recorded.

Memoirs of the Geological Survey of India. Palæontologia Indica. Ser. X. Indian Tertiary amd Post-Tertiary Vertebrata. Vol. I., Part IV. Supplement to Orania and Ruminants. By R. Lydekker. Calcutta; Geological Survey Office. London: Trübner and Co.

The author finds that the characters which induced him to separate the genera *Hemibos*, *Amphibos*, and *Peribos* are insufficient, and he consequently reunites them.

Vol. I., Part V. Siwalik and Narbada Proboscidea. By R. Lydekker.

This volume deals with the families Dinotheridæ and Elephantidæ. The former, now totally extinct, is characterised by the permanent dentition being in use at the same time, the second true molar having one ridge less than the preceding tooth. The genus *Dinotherium*, the only one of the family, makes an approach in the form of its cranium to some of the *Sirenia*,

especially *Halitherium*, but has also elephantine characters. Marsupial bones are said to have been developed. The genus is considered as a generalised form connecting the *Proboscidea* with the *Ungulata* and *Sirenia*. Three fossil Indian species have been distinguished, and are here described. In the second family, the Elephantidæ, never more than three teeth are in use at the same time, and the number of ridges is either equal to or greater than the number in the preceding tooth. The fossil species found in India, and here described, are *Mastodon falconei*, *M. pandionis*, *M. latidens*, *M. perimensis*, and *M. sivalensis*: *Stegodon Cliftii*, *S. bombifrons*, *S. insignis*, and *S. ganesa*; *Loxodon planifrons*, and *Euelephas hysudricus* and *E. namadicus*.

It thus appears that of the total of 38 known proboscideans, fossil and recent, no fewer than 16 belong to India, and 14 of these to the Siwalik period. Their extinction is ascribed by Prof. Huxley and Mr. Wallace to the Glacial epoch.

Ser. XIV. Tertiary and Upper Cretaceous Fauna of Western India. Vol. I., Part I. Sind Fossil Corals and Alcyonaria. By P. Martin Duncan, M.B., F.R.S.

In referring to previous works on the subject the author mentions that, in the great treatise of MM. d'Archiac and Haime, "Description des Animaux Fossiles du Groupe Nummulitique d'Inde," the localities are erroneously given as the Hala Mountains —a totally imaginary range. The Sind corals grow in a shallow sea, and form five very natural faunas, that of each geological series,—the cretaceous, nummulitic, upper nummulitic, oligocene, and miocene,—community of species being exceptional. The treatise consists of a description of the species which have been identified.

Vol. XV., Part II. Calcutta: Published for the Government of India.

This volume is devoted to an elaborate account of the Ramkola and Tatapani Coal-Fields, by C. L. Griesbach, F.G.S. Many of the seams are only a few inches in thickness, and afford little prospect of remunerative working. Others range up to 7, 9, and even 17 feet thick.

Vol. XVII., Part I. Calcutta: Printed for the Government of India.

This issue is an account of the geology of Western Sind, furnished by W. T. Blanford, F.R.S. The author draws attention to a primary distinction between the peninsular region of India, which has probably been land ever since the middle palæozoic

times, and the extra-peninsular regions—the Punjab, Sind, the Himalayas, and Assam—which have frequently been covered by sea. He treats in succession of the physical geography of the province, of its geological characteristics, and of its useful minerals. The latter unfortunately are far from numerous, and, save building stone and limestone, none are abundant. Coal has been found, but it is scant in quantity and poor in quality, being merely a lignite abounding in iron pyrites, and liable to spontaneous combustion.

There is an Appendix, by Mr. F. Fedden, on the distribution of the fossils in the tertiary and infra-tertiary groups of Sind.

Vol. XVII., Part II.

This part is an account of the Trans-Indus extension of the great Punjab Salt-Range, by Mr. A. B. Wynne, and is preceded by a prefatory notice from the pen of Mr. H. B. Medlicott, which proves—if proof were still needed—that there are occasional outbreaks of discord among the geologists of the great Indian Survey. We may perhaps be pardoned for remarking that we have not come upon anything of a similar nature in the reports of the American Survey of the Territories.

The region is characterised by the strange distortion of its rocks, which often assume the most singular colours,—green, blue, orange, and purple,—producing a fantastic scenery of which the illustrations give some idea. Gold is washed in the Indus and the Kuram, and in the former river is said to be accompanied by platinum, of which no recent evidence has been obtained.

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

"LIFE AND MIND ON THE BASIS OF MODERN MEDICINE."

"Thalassoplektos" and his friends having been allowed full scope for reply to our critique, we must now give our final opinion. Even granting, which we do not, that the scientific specialist is less happy than the country gentleman, &c., this is far from proving the position of our opponents. The child is happier in most cases than the adult, the barbarian than the civilised man, and, so far as we can judge, the ape in his native woods is happier than the vast majority of our species. But which is the higher? Mere "scientific education" is not research; and if man, when the "formative period" of his life is over and his powers are mature, is to turn his back upon Science, the progress of the world is at an end. Among individual men, just as among organic species in general, rise is effected by specialisation, and the "all-round" being, "*totus, teres atque rotundus*," is, in other words, a low generalised type. The reason why professional men do not desire their own career for their sons lies in our bad social arrangements, not in any fault of Science *per se*. Moreover, it is not difficult to find successive generations of scientists, *e.g.*, in the Darwin family.

The Editor.

THE FORMATIVE POWER IN NATURE.

To the Editor of the Journal of Science.

Sir,—The arguments and illustrations employed by Mr. Billing upon this topic, in your number for February last,—though of course not new ones,—are clearly and forcibly put; nor do I see how they can be controverted, except at the sacrifice of every

principle of analogy, and indeed of common sense. It strikes me, however, that when (at p. 84) he challenges those who, like Haeckel, deride Teleology, and substitute for it Spontaneity,—as a *vera causa* of living beings, to account for the *intelligence* so conspicuous in their construction,—he might have turned the tables upon them, or (to use an equally familiar phrase) "hoisted them with their own petard." He might have demanded the meaning of this word *spontaneity*, or *spontaneous generation*. Every tyro knows that these words are derived from "sponte" (*anglicè*, by will). *Whose* will, then, is meant when they speak of spontaneity? *Will* is a function of mind, not of matter,—an active attribute of a personal entity, or living being,—or it has no meaning at all. Do they mean, then, that the *will* that generates an organism can be *its own*, *i.e.*, that it could *act* before it *existed?* Such self-generation only exhibits self-contradiction in those who assert it; and the only alternative is, that the *will* is that of *another* being, and, as the result of its exercise is the production of what did not previously exist, this is no less than an act of *creation;* and if *matter can create* the term is an absurd misnomer, and should be replaced by that of God.

Nor will philosophic atheism gain much by calling this creative power Nature, or Monism, or any other *ism*. Call the Being which produces so unique a result what they will, this is the Being we Christians worship and adore as the Maker of all things and the Moral Governor of his rational creation. M. Haeckel himself admits (vol. i., p. 341) that such an event as he calls spontaneous generation must have occurred, at any rate, in the remote past, and may have occurred at any time since. We may congratulate the learned Professor on having discovered what the vast mass of thoughtful observers of Nature have been convinced of from the earliest times.

I must confess myself to be uncertain whether I understand the author's meaning in the following sentence (p. 82). Referring to the vast epochs of geology, he says—"Each of these eras presents different stratifications and forms, which stratifications could only have arisen from a solidification of the gaseous substance which we term the ether." Presuming that it is the lumi in germs that is here alluded to, which he seems to consider as a gas more subtle than those composing our atmosphere, I would observe that this theory is a mere assumption, and that it is more probable that this universal medium is a form of matter *sui generis*, and that the Creator, having made it absolutely independent of the force (whatever it is) which we call gravity, has rendered it thereby incapable of solidification. It is quite as conceivable that He should have originated a hundred or a thousand differing forms of matter as that He should have made *one*, and then so altered it by successive modifications and condensations that it became totally different in ten thousand other forms. In reality these two conceptions are little better than a distinction without a difference.

That the medium which is not only the vehicle, but probably the very substance of light and heat, if not of electricity and magnetism also, should be an element of vast importance in all cosmical phenomena, I am quite prepared to admit and maintain; but this is a very different thing from regarding it as *the* original fundamental form of matter.—I am, &c.,

H. B.

HEREDITARY QUALITIES IN ANIMALS.

To the Editor of the Journal of Science.

Sir,—In considering the question of hereditary qualities in animals, a fact has come under my observation proving that in birds the peculiar note of a race is hereditary, and I forward it because if I mistake not one of your correspondents stated the opposite to be the case.

A very young canary was purchased, and kept many weeks in my house; it could not sing at all, only twit: after a while it made divers attempts; most of us gave it up, but finally, in a month or two, it reached the perfect song of its race: it arrived at this point by stages and time, and continual practice. No other bird was in the house. It was a very young one when obtained. This seems a most decisive proof.

Now that man is generally acknowledged to be but a "superior animal," should not the results found in animal psychicism be applicable to man's mind?—I am, &c.,

David Y. Cliff.

NOTES.

We learn that the last work of Mr. Frank Buckland, completed two days before his death, and now published by the Society for Promoting Christian Knowledge, contains certain new arguments against the doctrine of Evolution.

According to the "Medical Press and Circular" the latest phase of the agitation for the suppression of physiological research is an "Anti-Vivisection Prayer Meeting," which was recently held in Nicholson Street Hall, Edinburgh.

M. Ch. Robin, in a communication to the Academy of Sciences, shows that well-marked sexual differences exist in eels, and that there are no grounds for supposing them to be hermaphrodites.

M. Alph. Milne-Edwards ("Comptes Rendus," 1881, p. 384), in summarising the results of deep-sea dredgings in the Caribbean Sea and the Gulf of Mexico, remarks that, on comparing the abysmal with the littoral animals, we seem to have before us two distinct faunæ belonging to different epochs and climates. The animals of the shore deposits belong to higher types, whilst those of the depths have a more ancient character; some of them present plain affinities with the fossils of the secondary epoch, whilst others recal the larval state of certain recent species.

In the same journal M. Bouilland demonstrates that the cerebellum is the nervous centre which co-ordinates the movements necessary for standing and for locomotion.

M. H. Viallanes, in a memoir on the histolysis of Dipterous larvæ during their post-embryonic development ("Comptes Rendus," February, 1881), shows that the muscles are destroyed at the moment when the larva passes into the pupa condition.

M. A. Certes ("Comptes Rendus," Feb., 1881) finds that Infusoria may be coloured a pale blue by means of a weak solution of quinoleine blue or cyanine, though they continue to live for twenty-four or thirty-six hours after. Quinoleine blue is eminently the microscopic reagent for fatty matter. The notion that the living cell is impermeable to colouring reagents must be abandoned.

According to M. Ch. Brame pure hydrocyanic acid remains undecomposed in the tissues of poisoned animals for a month, and is less easily removed by distillation from the bodies of the Carnivora than from those of the Herbivora.

According to a writer in the "Magazine of Pharmacy" the physical and chemical methods for the analysis of potable waters have proved themselves inadequate. "Recourse will have to be had to the microscope, and to the culture-glasses used by physiologists in their inoculation experiments, before any really sound and valuable knowledge can be gained by the examination of waters."

The "Popular Science Monthly" very fairly sums up the late Mr. Frank Buckland as "a writer who could seize with alacrity the popular side of a scientific question, but seldom went deeper."

It is alleged, though not on unquestionable authority, that a priest in Lerida, Spain, has cautioned his parishioners that any person who allows himself to be treated homœopathically in sickness will be refused absolution, and, in case of death, Christian burial.

M. Pasteur, in a communication to the Academy of Sciences, shows that disease-germs (microbia) may be gradually deprived of their virulence by artificial cultivation under certain conditions, and, on the other hand, may be brought back to their original condition by successive culture in the bodies of certain animals. The microbion of chicken cholera, after being rendered innocuous, may become deadly again if passed through the bodies of canaries or sparrows.

M. Peyrusson ("Comptes Rendus") has used hyponitrous ether as a disinfectant with great success.

MM. Couty and De Lacerda conclude, after a long course of experiments, that the venom of *Bothrops jacaranda* is not a true poison, but a special pathogenic agent, ranking with the virus class. The fatal dose for an ape is relatively a thousand times smaller than that for a frog.

According to MM. J. Kunckel and J. Gazagnaire ("Comptes Rendus") the swellings of nerve-matter found at the base of hairs in insects and crustaceans consist of bipolar cellules, connected on the one side with the axial cylinder of the nerve-fibre, and on the other with a rod capped with a true hair or a transformed hair.

Dr. Fatio finds that the spray of dry sulphurous acid, driven into the cases, &c., is a powerful and safe agent for destroying parasites in museums.

According to the "American Naturalist" a full-grown hen possessing three legs was sold in the market at Shelbyville, Tennessee. The intestine was divided about midway into four distinct canals, which became reunited, but finally terminated in two distinct vents. It had also two livers, one on each side.

The Rev. C. W. Dod, writing in the "Journal of the Society of Arts," says:—"I may add that a heavy plant-label is not altogether without its advantages. In the year 1842, when I was a boy at Eton, one of the many jackdaws which built in the College Chapel insisted upon having her nest so arranged that she could, whilst sitting, see out of the turret loophole, which looked towards Windsor Castle. This could only be done by making the foundation on a step of the spiral staircase, 9 feet below; and a massive nest, 9 feet high, was accordingly built. I made friends with the college clerk, and watched the progress of the nest, and recollect that amongst the materials, besides there being a box of lucifer-matches, garden-pegs seemed to be in great request. Three or four years later, when I was at Cambridge, I recollect the present Professor of Botany exhibiting, at a meeting of the Ray Club, a newly-devised label for use in the Botanic Garden there. It was a very heavy metal one—the weight, he said, being found necessary to prevent the jackdaws carrying them up for their nests between the roofs of King's College Chapel."

M. Ch. Fievez ("Comptes Rendus") considers that if, of two heavenly bodies, the one presents broader and more nebulous hydrogen rays than those of the other, the former possesses the higher temperature.

According to M. G. Rolland ("Comptes Rendus") a temperature of $-4{\cdot}7^\circ$ C. was experienced in the Sahara in the night between the 17th and 18th of January, 1880, the latitude being 35° N.

M. G. Rolland, in a paper read before the Academy of Sciences, considers it evident that the climate of North Africa, has become more arid since the Roman epoch, and that the Sahara in particular has deteriorated within traditional ages. This agrees with the remark of the Rev. Canon Tristram, that the fauna of the Sahara has a less decided desert character than that of Arabia.

Mr. F. H. Wenham, in a communication to Mr. J. Mayall, jun. ("Journ. Royal Micr. Soc., 1881, p. 121), gives, among other information, a method of setting the front lens of oil immersion objectives. The usual mode of "burnishing in" is difficult and uncertain, and to make an oil-tight fit the hard metal must bear heavily on the fragile glass, with the liability of distorting its figure. The following plan is recommended:—The cell is to be turned clear out, so that the lens would drop easily through. The cell is then heated, and a conical-pointed copper-wire, well tinned, and a fragment of rosin for a flux, is twisted round until a ring of tin is formed round the hole. The tin lining is then turned out true, to form the cell and bed for the lens, leaving the projecting ring necessary for burnishing. This operation is performed with an ivory stylet lubricated with soap. Before the

finishing touch is completed, if the face of the lens is seen to run out of truth (ascertained by the usual candle test), the soft metal will yield to a moderate degree of pressure applied to the proper side; the burnishing may then be completed without fear of the lens wabbling, and, finally, the edges neatly finished with the turning-tool. The soft tin plies so well round the glass that no leakage occurs with any kind of oil or spirit; and lenses thus mounted may be pushed out from the back of the cell for alteration or repair, without risk of fracture, as the tin is easily raised up without the application of a dangerous degree of force. The volatile oils and spirits used for immersion lenses act energetically in softening and dissolving either Canada balsam or shellac, and it will not answer to employ these substances for rendering them oil-tight. For the purpose of making a leaky joint tight Mr. Wenham has found ordinary sulphur to answer perfectly, as it is not acted upon by any cold immersion fluids that can be used; and as its melting-point is about 220° F., the heat required for its employment will not injure the coat of lacquer on brass work. In order to cement a front lens oil-tight in its cell it is sufficient to place this, with the lens fitted in position, on a hot plate, and drop a fragment of sulphur on the lens, raise the heat till the sulphur melts and flows round the edge. By capillary attraction it runs into the joint. Although melted sulphur is very fluid, yet it has a singular disinclination to attach itself or spread on a polished surface of glass; and this property prevents it creeping over the back of the lens as balsam or shellac would do, and when cold the button of sulphur may easily be picked off with a needle-point, leaving the surface of the glass clean.

Some years ago a standard screw for the fitting of objectives was determined on by the Royal Microscopical Society, and tools were issued, the result being the universal adoption of the Society's gauge. Latterly the stock has become exhausted; the Council have, however, completed arrangements for a further supply: sets, consisting of a gauge and pair of screw tools, can now be obtained on application to the Assistant-Secretary.

A writer to "Science Gossip" recommends the following contrivance for conveying moist specimens by post:—Thin gutta-percha, such as is used by surgeons, is cut to the required size. The joint is made by dipping a camel-hair brush in chloroform, drawing it along the edge, and then placing the part to be joined to it before the chloroform has evaporated. If the tubes are only three parts full, it will allow of a little pressure should it occur in transit. The cover can be made by rolling brown paper over a ruler or other suitable form, fastening with paste, as firework cases are made, allowing to dry, then cut to lengths required.

NINETEENTH YEAR OF PUBLICATION.

THE

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THE

JOURNAL OF SCIENCE.

MAY, 1881.

I. SCIENTIFIC ARROGANCE.

By Robert Ward.

THEOLOGIANS and their followers not unfrequently complain of the arrogance of men of science; to which it has been replied that "No class of men, however highly instructed, is wholly free from faults of judgment and taste, and there is no reason for expecting men of science to be more than human in this respect." And it may be at once conceded that the arrogance of men of science is quite equalled by the dogmatism of professors of religion; but I would respectfully suggest that the one is more excusable than the other. The scientist prides himself upon being guided by reason as exercised by observation of Nature; the religionist confessedly relies upon authority as represented by the Church of his Fathers, to which he turns for guidance on all difficult questions. The one may be said to believe in himself or his own powers of discernment; the other humbly, though it may be blindly, follows what he believes to be the wisdom of his ancestors. Positiveness of opinion is therefore excusable in the religionist, because founded in modesty; but when the scientist, abandoning reason, appeals to prejudice, he certainly indulges in an arrogance which may be described as wholly indefensible, because founded in conceit. I can best illustrate my argument by reference to an example. I happen to be the unfortunate author of a book entitled "The Constitution of the Earth," of which the following is a criticism:—

"Mr. Robert Ward's book is one of those odd argumentative works which the late Professor De Morgan would

undoubtedly have included in his 'Bundle of Paradoxes.' Mr. Ward's particular paradox consists in a belief that the world and the solar system generally are growing bigger. Those misguided authorities, the astronomers, from Laplace downward, have been of opinion that they were contracting; but Mr. Ward has changed all that, and 'shows cause' why they are now and have always been expanding. The planets, it seems, are little orbs knocked off from the Sun; and they are receding from it, instead of slowly approaching it, as the physicists vainly talk. The older a planet is, the farther has it got from the Sun. Moreover, it picks up a satellite or two on the way; and the age of a world may thus be roughly guessed by observing how many moons it has managed to annex. As planets become older they become hotter. 'Growing old is growing cold,' says the ancient proverb; and certainly the accepted doctrine that heat radiates would seem to lead towards the same conclusion; but Mr. Ward has changed all that too, and announces that the crust of the Earth is cracking, not because of contraction in the molten centre, but because of expansion. Altogether physical science is turned upside down by him with a boldness and originality quite remarkable. Chemists, physicists, astronomers, and biologists are all equally wrong. Matter is constantly coming into existence and passing away. Sunbeams add many thousand tons annually to the Earth's weight. Rain falls from the sky direct, and is not, as meteorologists absurdly assert, a product of evaporation. And so forth. All this is very excellent fooling; but there is a method in Mr. Ward's madness none the less. In spite of profound ignorance of many simple chemical and physical facts, gleams of real cleverness burst out here and there: while you have only to reverse exactly all that he says about the solar system, and you get a forcible and in many ways original summary of the current nebular hypothesis. If Mr. Ward were possessed of a really scientific training he would probably have made a bold and vigorous inquirer; as it is, he has only succeeded in producing an exceedingly absurd and extravagant work."

As the publication from which I have quoted is accustomed to insert letters, I addressed the following to the editor, in the hope that he would allow me to show that my book was not quite so "absurd and extravagant" as it was represented:—

"Sir,—Will you kindly permit me to correct a mistake into which your reviewer has fallen when noticing my book, 'The Constitution of the Earth,' a few days ago? He

represents my conclusions as at variance with those of scientists in general. Of course, to the extent that a book contains anything original, it must differ from the opinions expressed by other writers; but I believe that what is described as 'the evolution of species' is a very commonly-accepted doctrine of scientists at the present time. My book might have been appropriately enough entitled 'The Evolution of the Earth.' It simply assumes that the same laws which have been observed in the creation of species have also been concerned in the origin and development of the globe upon which they stand; that, in short, the evolution of species has been part of a great scheme of creation by which the Earth itself has undergone a progressive development. And certainly this conclusion is not inconsistent with the general teaching of geologists, who assume that the *conditions* fitted for the existence of a higher development of animal and vegetable life must have preceded their actual existence on the Earth. It is true that I do not believe in the *theory* of some modern astronomers who think that the Earth and all the other planetary bodies are destined to drop into the Sun; but, as a matter of *fact*, the latest measurement of the Earth's distance from the Sun in connection with the transit of Venus is entirely confirmatory of my view of creation, and shows that the Earth is *receding* from the Sun. And previous measurements supported the same conclusion."

I think it will be allowed that my language could not have been more conciliatory and temperate, and yet I have waited in vain for the publication of my letter. It is obvious that my critic professes to be "a man of science." Indeed he must have fathomed the depth of my "ignorance of many simple chemical and physical facts," or otherwise he could not have discovered the extent of their profundity,—an intellectual exploit which fills me with astonishment. Certainly it would be difficult to give an account of my book more illustrative of scientific arrogance or more calculated to mislead the reader as to its true character. Instead of relying upon reason and observation to confute my "very excellent fooling," he appeals to prejudice throughout, and presents the reader with a garbled and fanciful account of the contents of my book. I am represented as wholly at variance with "chemists, physicists, astronomers, and biologists," whilst in reality the views I have propounded are largely supported by quotations from writers in the several departments of science; so much so that my fault has been described by a friendly critic as "over-quotation." It is

true that science is full of paradoxes; hence the continuous stream of new books, which are all in some degree at variance with "received opinion," and therefore more or less paradoxical. I flatter myself that the views I have enunciated in my book may be found to reconcile many interpretations of Nature hitherto considered antagonistic, and, in particular, I believe that I have done something towards reconciling the fundamental truths of religion and science.

My critic represents me as declaring unconditionally that "matter is constantly coming into existence and passing away." It is true that, in answer to Prof. Haeckel, I say that "Really experience—that is the knowledge communicated to our consciousness through the senses—is continually showing us matter in the process of coming into existence and passing away. That a natural body, when 'it seems to disappear,' does not actually disappear, is a pure theory. Abstract matter—that is matter devoid of every quality by which matter is known to us—never disappears, for the simple reason that it is an abstraction, and has no more sensible existence than any other metaphysical conception." I believe that Mr. Herbert Spencer and Prof. Huxley would both support me in this conclusion. I am also reported as asserting that "Sunbeams add many thousand tons annually to the Earth's weight. Rain falls from the sky direct, and is not, as meteorologists absurdly assert, a production of evaporation." I do so say that the light of the sun has been an important factor in the formation of the coal-measures, and, with George Stephenson, I am disposed to describe coal as "bottled-up" sunshine. Rain certainly "falls from the sky direct," whatever meteorologists may say as to the process by which it gets there. Chemists tell us that water is composed of two gases, and Laplace taught that the solar system was formed out of a gaseous fluid which occupied interstellar space.

The religionist says that science is a paradox; the scientist says that religion is a paradox. Which is right? I do not believe that either is literally accurate, but I do say that they are fundamentally reconcilable. The biologist and the geologist both say that life on the Earth has undergone a progressive development, and the latter concludes that such could only arise from a corresponding improvement in the condition of the Earth itself; but my critic, who is profoundly acquainted with the nature of heat, paradoxically assumes that the Earth is growing colder, and that man and all living things are destined to be frozen out of existence

and the Earth itself swallowed up by the Sun! As a matter of fact, when a base line has been measured a second time after the lapse of years, it has been found longer. If we may rely on Ordnance surveys and private measurements the acreage of England is increasing, but my critic declares nevertheless that the Earth is contracting! According to the recent measurement of the Earth's distance from the Sun it is very nearly a million of miles more distant than the estimate of Newcomb, deduced from observations by six methods; it is more than a million of miles more distant than Leverrier's estimate from the planetary disturbances; and it is no less than 1,800,000 miles more distant than was shown by the transit observations of Stone in 1769. And yet my critic insists that, instead of the Earth receding from the Sun, it is moving in the reverse direction!

I have no idea of escaping criticism. It is exceedingly undesirable that new interpretations of Nature should be too readily accepted; but if, in its publication, I have "only succeeded in producing an absurd and extravagant work," it should be easy to demonstrate such conclusion. It is described as "odd" and "argumentative." I do not know that either of these qualities is necessarily objectionable, although I admit that originality is a fault if unaccompanied by a reference to facts or unsupported by reason. To be argumentative I have hitherto believed to be at least plausibly in the right, and certainly the reverse of "absurd and extravagant." Why did not my critic, instead of appealing to his own imagination for a description of my book, give a true account of its contents? He might at least have shown what, in an argumentative way (as he confesses), the book professes to teach. Must I conclude he was afraid that a mere summary of its contents might go far to satisfy his readers that there was at least something in it worthy of their investigation, and which could not be got rid of by a supercilious assertion as to its absurdity?

If the effect of having received a "really scientific training" would simply have been to have bound me down to the existing modes of scientific thought, I should probably not have disturbed the mind of my critic in the way that I have done. I should have been content to have taken my place in the rank and file of modern science, conscious that there are many persons better qualified than myself to take the part of schoolmaster. But Science has not been created, however much it may have been extended, by a system of schooling.

The introductory chapter of my book explains how, so far

back as 1842, I found myself constrained to conclude that, if we once admit the power of circumstances to effect any change, however small, in animal forms, its efficiency to produce further change must be governed by the presence or absence of the necessary modifying conditions, *to which alone must be assigned any actual limit.* That circumstances were capable of producing some degree of change had never been disputed by any intelligent person. Distinguished naturalists had contended that the dog never existed in a state of primitive nature, but that it was the result of an intermixture of several species; and others, equally eminent, contended that it was a modification of the wolf, the jackal, or the fox. No one disputed that circumstances might wonderfully modify any particular species, and such modifications were known as varieties, and strikingly exemplified in the many different forms of the dog. I thus reasoned:—"If, as is admitted, circumstances can so change the form and nature of the wolf as to produce a dog, why may circumstances not so operate upon the dog as to produce a further change of like extent? And what reason have we to conclude that the change may not go on indefinitely? Or—to express the idea mathematically—if 1 (the wolf) may, by circumstances, be turned into 2 (the dog), why may not 2 be changed into 3 (some other animal differing as much from the dog as the latter differs from the wolf), 3 into 4, and so on to any extent?"

The modern term for such transmutation of species as thus seems inevitable, if the necessary conditions are present, is "Evolution," and hundreds of volumes have been written, during the past twenty years, in its support; but it appears to me that the words I have quoted fully establish the possibility of unlimited change. In "The Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life," Mr. Charles Darwin enters into an elaborate explanation of a process by which the transmutation of species may have taken place. I have no fault to find with his mode of showing that "natural selection" is an agent capable of producing an infinite amount of change in animal forms. He has been wonderfully successful in establishing the doctrine that animals now existing may have been evolved from simpler forms which lived in the earlier periods of geological history; but nevertheless he hesitates to set up "natural selection" as the all-sufficient origin of species, and a belief in their absolute immutability is really a remnant of the Paganism which discovered spirits, gods, or demons in all the most

striking objects of Nature. I affirm that the evolution of species is part of a great plan of creation in which every form of matter is subservient to the purposes of an ever-present Creator, and I fail to see anything "absurd or extravagant" in a conception which is consistent with the fundamental principles of a religion which has largely influenced the thoughts and actions of wise and good men in past ages. To my mind a view of evolution which reconciles, even though imperfectly, the realities of science with the truths of religion, instead of being an object of scorn and misrepresentation, vastly increases its claims to acceptance.

In the second chapter, on "Mind and Matter," I quote at length the introductory chapter of an "Essay on the Constitution of the Earth," published in 1844, to show that man's comprehension of Nature, instead of being, in any case, absolute or perfect, is only relative or comparative. This idea has been elaborated under the title of the relativity of human knowledge, and is, I believe, accepted by scientists who claim to have received a "really scientific training," and who profess to be the recipients of the most exact knowledge. But I argue that the fact that our understanding is limited affords no reason for concluding that we are totally devoid of understanding, and that this applies alike to spirit and matter—to God and Nature; which conclusion is further elucidated in the third chapter. If the belief in an Over-ruling Providence is the fault of my book, why not expose the weakness of my argument in its support?

The next five chapters of my book deal with the laws of God in creation, by which existing things have been developed from those which prevailed in the past. By a law of creation I mean the order, harmony, and consistency observable in the processes by which the changes in Nature have been produced. As already suggested, these changes are governed by the presence or absence of the necessary modifying conditions. Mr. Darwin's theory of the origin of species by means of natural selection admittedly depends upon the selection of *progressive* variations. "Nothing," he says, "can be effected unless favourable variations occur;" that is, favourable to the development of new species. Natural selection, he observes, acts exclusively "by the preservation and accumulation of variations which are beneficial under the organic and inorganic conditions of life to which each creature is at each successive period exposed." Hence Mr. Darwin consigns the origin of species, from natural selection, to the conditions or circumstances favourable to

progressive change or development. The creation of species, he in effect argues, is not the result of natural selection, but of conditions which promote a change (progressive or otherwise ?) so great as to represent a new species. This is my conclusion :—I suggest that *the progressive development of species could only arise in connection with a corresponding development of the Earth itself;* and I have propounded what I conceive to be the laws which govern not only the creation of species, but every form of matter; which laws are given at length in my book, and, briefly, in an article which appeared in the "Journal of Science" for August last.

The ire of my critic seems to have been especially roused by the ninth chapter, which suggests that the Earth has derived its existence from the Sun by processes still in operation, and by the astronomical evidence in its support which is given in the next chapter. He appears to have a vested interest in the theory that the Earth and all that is upon it are destined only to afford fuel to keep up for a little time longer the fire that is consuming the Sun. He represents me as affirming that the planets are little orbs "knocked off" from the Sun, and that they are "picking up" their satellites on the way. Such a description might be consistent enough with the mechanical view of Nature which, contrary to the teaching of Newton, sets up gravitation as the god of creation, but it is utterly opposed to the teaching of my book. I show, on the contrary, that plants and animals are constituted with strict reference to the present condition of the Earth. To use the words of the late Dr. Phillips :—"Deprive the atmosphere of its carbonic acid—plants disappear; let phosphate of lime be absent—not only vertebrate animals vanish, but a large part of both the animal and vegetable race would languish and become unproductive." Paley's "Natural Theology" is an elaborate exposition of the relationship which subsists between animal and vegetable existence as now enduring and the Earth's present condition. The constitution of vegetable and animal existence is, in fact, governed by the constitution of the Earth, and it therefore follows that their constitutional changes, as described by geologists, afford evidence of a general corresponding change in the constitution of the Earth. This relationship is entirely inconsistent with the idea of a body falling into the Sun as the result of a blind mechanical force. Attraction describes a relationship, but not a reason of relationship; it expresses a motion, but not a reason of motion. If it be asserted that the Earth is advancing towards the Sun because it is attracted by it, it may be replied that it is

receding from the Sun because it is repulsed by it. If it be asserted that the Earth is attracted by the Sun because it is not further from it, it may be replied that it is repulsed by the Sun because it is not nearer to it. I assert that the attraction or repulsion is the result of a constitutional relationship consequent upon the laws of God in Nature. This relationship has arisen out of the circumstances under which the Earth has been created. The Earth has been constituted under the influence of the Sun, any change in its relationship to which would, proportionately to its importance, change its present condition, just as any change in that condition would effect a change in its entire plant and animal life. Hence I assert that the Earth has derived its existence from the Sun, just as the oak tree has derived its existence from the soil into which the acorn was planted, and by its relationship to which the tree has passed through all the phases which commenced in its first fructification. The Earth's present existence is consequent upon that of the Sun; and as, by the theory of Evolution, its present existence has been derived from the past up to the remotest beginning, its past existence must have been derived from the Sun. I have shown that there is a relation between the sizes of the planets and their distances from the Sun; between the number of satellites of a planet and its distance from the Sun; between the velocity of the revolutionary motion of a planet and its distance from the Sun; and between the rotary motion of a planet and its distance from the Sun; all of which relationships are suggestive of a higher development of the more distant planets. I fail, therefore, to see that there is anything "absurd or extravagant" in the belief that they all originated in the Sun, and that there is a relationship between their ages and their distances from that body. Notwithstanding the proverb, I do not know that growing old is growing cold; I have never heard of the "accepted doctrine" that heat radiates under all conditions; I am certainly not aware that the Earth is growing cold; but some eminent scientists do tell us that there is a constant relationship between heat and motion, and I believe it is a fact that the more distant, and, as I believe, the older planets, have much quicker rotary motions than those which are nearer to the Sun.

In answer to the charge of arrogance which has been brought against them, I have seen it stated that it is certainly not true that men of science, as a body, or the leaders of physical science in particular, have used a tone of overbearing confidence or wanton insult, and I am willing to

endorse the statement. But I am constrained to conclude that my unknown critic is the exception which makes good the rule that "No class of men, however highly instructed, is wholly free from faults of judgment and taste."

II. THE EVOLUTION OF THE SOLAR SYSTEM.

By Charles Morris.

IN the nebular hypothesis of the formation of the Solar System it is argued that, in an original vast expanse of nebulous matter, centripetal attraction set up rotation of the mass as a whole; that speed of rotation and density of aggregation increased together; that eventually ring after ring of condensed matter separated from the outer edges of the rotating disk; and that, finally, these rings broke up, and their materials aggregated into the planetary masses.

In my article on "The Evolution of the Spheres," in the "Journal of Science" (March, 1881), I have temporarily assented to this view; but a fuller consideration of the subject requires that a somewhat different view be taken. In such a mass of nebulous matter homogeneous diffusion would be simply impossible. Yet if there were heterogeneous diffusion the force of centripetal attraction could not be confined to the centre of the mass, but must also display itself in minor portions of the mass. There would undoubtedly be a general centre of atraction, affecting the mass as a whole; but there would also be minor centres of attraction, affecting certain portions of the heterogeneous mass. Thus, while the nebula as a whole condensed and rotated around its centre, its constituents must also have set up an independent condensation and rotation of their own; the tendency being for the vast mass to separate into many smaller masses, each of which, while yielding to the central attraction, pursued its own independent interior development.

Nor would these minor masses display any similarity in size. In a huge heterogeneous mass of nebulous matter

there must be tracts of partial homogeneity, greatly varying in dimensions; and also dense regions, probably contiguous to rare regions, marking out natural localities of minor aggregation. Thus there is reason to believe that, in the original mass, centres of force of greatly diversified influence displayed themselves, and that the minor aggregations resulting ranged in size from planetary to meteoric dimensions. It is probable, indeed, that this process affected every portion of the mass, the condensing planetary masses being full of minor centres of aggregation of their own, and this possibly extending down to the formation of atomic masses from the heterogeneous aggregate.

But we are here simply concerned with the original independent masses, not with their interior evolution. In respect to the formation of these the centripetal attraction of the whole mass must necessarily possess a vigorous influence. In regions near the centre this influence would be very powerful. The minor aggregations being there formed under the influence of a vigorous central attraction must necessarily be smaller in size, as they could only affect a limited region of the nebula. Their centripetal attraction, at a certain limited distance from their centres, would be overbalanced by the attraction of the general centre, and all substance beyond this distance be swept off towards the solar centre. Of course the size of such minor aggregations must have depended upon the density of the matter from which they were originally composed, and they may thus have greatly varied in dimensions; but they could not have assumed very great dimensions, on account of the overmastering vigour of the central attraction upon their outlying regions.

In the outer portions of the nebula the state of affairs would be markedly different. Here the vigour of central attraction would be greatly reduced, and thus the influence of minor centres might extend to a much greater distance outwardly. Therefore vast regions of the nebula might be brought under the influence of a single minor centre, arising in a partly condensed portion of the mass, before the distance from this centre became so great that its attraction was overbalanced by that of the general centripetal force. Consequently, if the diffusion of the mass made any approach to homogeneity, there must have arisen in it numerous minor masses, increasing in size outwardly with some regularity, and all subordinate in their general motions to the central attraction of the whole mass. This centripetal attraction must remain virtually the same whether the

nebulæ continue in a diffused state, or become aggregated into a sun and attendant planets.

But as it is by no means probable that the original mass approached an equality of diffusion, so it is not probable that any such regular arrangement of the minor masses could result. As a general rule they must have been smaller near the centre of the nebula, and larger in its exterior regions, but beyond this general arrangement their sizes must have been dependent upon the condition of diffusion in the original mass. Every condensed portion of this original mass would tend to set up a local action of aggregation, and the position of the largest secondary aggregate would be governed by the possible existence in the original nebula of some wide field of denser matter, sufficiently removed from the centre to escape the interfering action of the vigorous central energy.

Such seems probable to have been the original process of mass development in the nebula from which the Solar System arose. An allegiance of the mass as a whole to the attractive vigour emanating from its centre; an allegiance of secondary condensed portions of the mass to the attraction of their centres; and a gradual formation of minor aggregates as constituent portions of the great aggregate; these secondary masses increasing in size, but not regularly outwardly from the centre.

These, however, were not the planetary masses we now possess. Nor were they defined rings of condensed matter, or of small masses. They were, more likely, a vast number of small rotating masses, of every imaginable size, and occupying the most irregular positions, circulating around the centre in an immense variety of orbits. If, indeed, we conceive of the original nebula as condensing into a rotating disk, we may conceive of this secondary stage of its evolution as a gathering of its matter into secondary masses, which occupied the whole extent of the original disk. The nebular sun in the centre was thus surrounded by an immense number of planets, of every imaginable size, radius of orbit, and speed of revolution, every radius of the circle around the centre being occupied, at any one moment, by several of these planets. These orbits might be variously elliptical, and out of the plane of the Ecliptic. For the general motion of the masses would have two components of direction, one arising from their allegiance to the central energy, and one from their own condensation—this yielding motion in a direction opposite to that in which the general heat emission took place (as argued at length in the article

above referred to). But it is probable that these masses were not, as a rule, of great dimensions. It seems more likely that a comparatively few great masses would alone exist, their production hindering a like process in the remaining portions of the nebula, on the same principle as that by which the sun hindered them in regions near the centre, through the overbalancing influence of its vigorous attractions. We may thus imagine a vast array of such revolving masses, as a rule of comparatively small dimensions, while among them moved a few much larger masses, irregularly placed as regarded the centre, but with a general tendency to increase of size outwardly. Between these masses the nebular substance must have become greatly rarefied, it being denuded of its material both by the dense masses that moved through it and by the solar attraction, this material condensing towards that attracting body, whether sun or planet, which had the most vigorous influence at each locality.

These secondary masses, however, would not be related to each other as they would to the central mass. In their relations with this there would be a balanced agreement between the speed of revolution and the force of attraction. But in masses moving in nearly parallel orbits around a common centre there would be no such resistance to the effects of their common attractions. Their orbits would tend to approach each other. Every large mass might thus bring a lateral force to bear upon the small mass to a considerable distance on each side. And as scarcely any two of the small planets would have precisely the same orbital speed, they would constantly overtake, or be overtaken by, the larger masses in their annual revolutions, and thus be drawn more and more towards these larger centres of force, through the effect of lateral pull, until eventually aggregation would arise between the parallel moving bodies.

Such huge original aggregates as we may conceive the primary core of Jupiter to have been may have thus swept a vast extent of space of its smaller bodies, and gradually gathered them into its own mass, its attractive energy increasing with every such addition to its matter. Thus the few larger spheres may have grown at the expense of the smaller spheres, swallowing up all these except those moving at their own speed and in a distant part of their own orbits. But these again would be subject to perturbations from the attractions of distant large orbs, and thus brought into positions exposing them to overwhelming lateral attractions.

Of course, in such a process, other conditions than those here considered might arise. In vast regions of the nebula it is possible that no single mass might aggregate sufficiently large for its energy to overpower the resistance of its neighbours. In such a case the minor masses might preserve their individuality, and continue to revolve as separate planets around the centre. But such a condition could arise only under special relations between the Sun and its attendant planets; and these relations exist in one portion of our Solar System, in the region of the asteroids. The huge mass of Jupiter has swept the space beyond these of all its minor planets. But the influence of its perturbing attraction is constantly exerted against the counter influence of the Sun, and at a certain distance inward the solar attraction must have hindered perturbations sufficiently wide to bring the minor planets within the grasp of Jupiter. For a vast space inward from this limit the quantity of matter seems to have been comparatively small. The next inner planet is Mars, one of the smallest of these bodies, and quite incapable of greatly perturbing, or of drawing to itself masses at the distance of the asteroids. In this ring of asteroids, then, and in their great diversity of orbits, we seem to perceive a permanent remnant of a temporary condition of the Solar System, ere the overmastering attraction of the larger masses had denuded the space in their vicinity of all similar minor planets.

It is by no means impossible that cometary masses arose from the same causes. Small bodies, whose orbital revolution was greatly disturbed by the perturbing attraction of the large masses, and which yet succeeded in escaping from this influence, might well have gained very elliptical orbits through these vigorous lateral attractions, and been forced to assume the most diversified directions of revolution around the centre.

The final direction of revolution of the planetary masses would necessarily be the complement of the many motive influences which arose from their mode of aggregation and the various perturbations to which they were subjected, their orbits thus becoming necessarily more or less elliptical, and inclined to the Ecliptic.

Again, as Nature knows no great or small, and as her principles of operation constantly work to the same result in the same general conditions, without reference to the quantity of matter concerned, so we may reasonably look for similar results to arise during the condensation of the planets. These were probably at first gaseous in aggregation,

and heterogeneous in diffusion of their materials. Consequently it seems as if a similar process to that above considered must have displayed itself in the planets, the outer portions of their substance condensing into numerous smaller bodies, and these again gathering, under the influence of their larger individuals, into moons. And in the moons we have an instance significantly like that of the asteroids. For the rings of Saturn seem to present an instance of such an array of smaller revolving masses, too much under the influence of the planetary attraction to be swept away by the outer moons, and with no large mass capable of acting as a minor centre of aggregation of the materials of the rings.

In the astral system, of which our Sun possibly forms part, a similar process of aggregation may have gone on; in which case our Solar System would be but the outcome of one of the secondary aggregations of the general mass, while the vast rarefied space between the spheres of this astral system would answer to the lesser rarefied spaces between our planets. Likewise, as the comets which appertain to our system may have arisen from some of the original small masses, which retained their independence through being forced into very elliptical orbits, so the comets which come from without our system may have arisen in like matter in this intermediate space, and have gained their irregular orbits through the overbalancing attractions of Solar Systems.

If such cometary masses took part in any degree in the formation of planets, they would be a disturbing agent adding to the tendency of irregularity in the planetary motions. Such irregularity, whether arising from this cause or from lack of central influence, must be most declared outwardly, and in our system is most evident in the outermost planets. The moons of these planets are even unconformable in their motions to the direction of the solar influence, but not to that of their immediate attracting centre, to which they are simply eccentric.*

Another question of importance in this connection concerns the evolutionary processes in the planets, subsequent to their condensation into solidified masses. It is generally taken for granted that suns and planets now contain their

* It is very probable, also, that in the condensation of a heterogeneous nebula the centre of gravity would not be the centre of volume. If so, the mass as a whole would describe an elliptical movement, while its minor components might assume variously elliptical orbits, from their special individual relations to this centre of attraction.

utmost quantity of matter, except as they may be added to by meteoric accretion. One hypothesis argues that the Earth, and presumably all planets, will eventually absorb all its seas and atmosphere, and afterwards roll on through space, a dead world. Yet it is possible that these conclusions have been too hastily reached.

It was formerly argued that the atmosphere, from its rate of decrease of density, must cease to exist at a height of some fifty miles from the surface. Yet we now know that it is sufficiently dense to produce incandescence, through friction with meteoric bodies, at a height of several hundred miles, and may extend to a much greater height in a more diffused state. Thus we have some reason to believe that it has no real limit, but shades off imperceptibly into the matter of space, this matter being condensed around every orb, and gradually rarefied outwardly.

It might be supposed, however, that we could imagine a true limit to the atmosphere at that point where it ceases to be sufficiently controlled by the earth's atmosphere to be obliged to rotate with it. But we hope to show that there is no such limiting point, and that the atmosphere in this respect also shades off into the inter-spheral conditions of substance. The earth is a globe of matter limited in size by two diverse forces—the centripetal force of gravity, and the centrifugal force of rotation. Its gravitative vigour depends upon its material contents and their degree of condensation. To this vigour the atmosphere adds very little. The density of the material possessed by the earth is not a direct consequent of gravitative force. It arises partly from a secondary effect, that of local aggregation from the gaseous into the liquid and solid forms. Through this local action the condensation of matter became much greater, and thus its immediate gravitative effect was greatly enhanced. This has, of course, much increased the density of the atmosphere, and every such increase in the density and decrease of size in the solid mass must add to the atmospheric density, by bringing the gaseous substance nearer to the centre of gravity, and increasing the gravitative pressure upon it. But if we pass outward into space, to the point to which the material now composing the earth and its atmosphere extended in its nebulous condition, we will find that any substance beyond this point is entirely unaffected by the earth's condensation and solidification. The effect upon this outer sphere of matter depends only on the quantity of material within it, and it matters not whether that material be in a state of gaseous diffusion or of solid condensation.

But if the effect of condensation has been to add any new matter to that originally possessed by the nebulous earth, then the influence upon outer substance must have increased. And there is no reason to doubt that such new matter has been added. For as the nebulous mass condensed into its solid state it would, of course, denude a vast extent of space of its material contents, thus tending to produce an abnormal vacuum unless exterior matter pressed, both through its power of diffusion and as a result of terrestrial attraction, into this denuded space. It is very probable, then, that the condensation of the earth has added to the quantity of substance within its range of influence, and that any solidification of its existing atmosphere would tend to produce a new and denser atmosphere, through the influence of increased gravitative energy.

But now we may again ask, what portion of this gaseous envelope of the earth really belongs to it as atmosphere? There are two forces involved in considering this question—that of gravitation, and that of centrifugal energy of rotation. Gravitation in itself does not cause the matter upon which it acts to rotate. Rotation is a secondary effect, whose cause we need not consider here. But we can safely say that this cause weakens as we reach a considerable distance outward from the centre, and that much of the rotation which exists comes from a tertiary cause, that of friction. But this, again, is an influence which weakens outwardly, through the growing rarity of matter. The particles composing the solid crust of the earth are forced to rotate in unison, through their mutual friction. It is the same with the particles composing the lower atmosphere. But as we ascend into the region of the rarer atmosphere this frictional effect rapidly decreases. It decreases, in fact, just where it should increase, if the necessary result is to be produced. For as we leave the centre the rapidity of rotation must increase, through the increased length of orbit of the particles. Necessarily, then, as both the forces that produce rotation decrease in this rare outer atmosphere, the rotation itself must lag. The spheres of outer atmosphere must fall behind those of the inner atmosphere through the rapid diminution of the frictional influence. Instead, then, of the earth possessing an atmosphere which revolves in unison with it to a certain point outwards, and then suddenly ceases to revolve, it is far more probable that its atmosphere begins to lose its rotating energy as soon as its denser regions are passed, and that it rotates less and less rapidly with the continual decrease in frictional influence, until all rotation

ceases, and it becomes continuous in condition with the matter of space. At this undefined point we reach the true atmospheric limit, or the outermost point of direct allegiance of outer matter to the earth. This limit perhaps constantly varies. At every approach of a planet the gravitative influence of the earth is partly neutralised, the density of the atmosphere decreased, and its frictional power reduced. The influence of the sun and moon must produce still more marked results; and the atmospheric perturbations and storms are, no doubt, very largely due to these exterior influences upon its density.

If the earth were at rest in space the result of the above action would be to give the atmosphere a shape markedly different from that of the solid earth. For as we pass from the Equator towards the Poles the rotatory vigour decreases, and becomes null at the immediate poles. Consequently atmospheric friction might be more effective in producing the decreased centrifugal motion required, and the true atmosphere would assume the shape of an elongated spindle, its axis extending in the line of the poles.

But the earth is not at rest in space. It is moving through space at a very rapid speed. Thus the friction of its atmosphere is not alone concerned in producing rotation in surrounding matter, but also in carrying this matter forward with the earth in its flight through space, as a permanent envelope. Here, too, there is a resistance of outer matter to this influence, and a disposition to lag. Probably to a certain distance outward the combined gravitative and frictional vigour of the earth carries this atmospheric matter forward at its full speed. Beyond this distance these influences so weaken that the matter of space lags behind in the race. This lagging increases until, at a certain limit of distance, the atmospheric matter quite ceases to accompany the earth in its orbital flight. Here is another atmospheric limit, shading off and imperceptibly disappearing like the former. Its shape, however, should be spherical, since its producing influence would be equal in all directions from the centre.

As remarked above, the effect of absorption of the existing atmosphere into the earth's crust would necessarily be to increase the earth's gravity, and thus to attract new matter into this denuded space. But another consideration arises here. Our atmosphere, in its lower portions at least, is not composed of disintegrated matter, but of chemical atoms and molecules, matter in a state of partial condensation. It is not at all probable that the matter of space exists in

this integrant condition. It is, doubtless, largely or wholly disintegrated. As to the matter composing our atmosphere, we are ignorant of its condition beyond a very limited height. Near the surface it is composed of oxygen and nitrogen, with small quantities of some chemical compounds. At a comparatively small distance from the surface these chemical compounds may cease to exist. But it is quite possible that here the oxygen and nitrogen are accompanied by a third elementary constituent, namely, hydrogen. For in the excessive rarity and active molecular motion of the atmosphere at this level, hydrogen may be insusceptible to the attraction of oxygen. Though the apparent temperature may be low, the absolute temperature is high in all such rare gases, from their greatly increased heat capacity. Thus, at a certain lower limit of rarity, oxygen and hydrogen may be so related in their vigour of molecular movement as to yield to their mutual attractions, and combine into water vapour; while beyond this limit their absolute temperature may be too high to permit of such combination, and they will remain separate. At a still higher level it is probable that oxygen and nitrogen may cease to exist, as such, and become separated into their simpler constituents; while hydrogen, from its lighter character, may remain intact to a much greater altitude. Yet it, too, must eventually separate into its constituents, if it is really molecular in condition. Finally, the rarification may become so extreme, and the absolute temperature so great, that the matter concerned in our atmospheres may separate into its primary atoms, or possibly into its ethereal or completely disintegrated state.

The density of atmospheres, therefore, depends not simply on the condensing effect of spheres upon the matter of space. For this condensing influence, by reducing the distance between particles and lowering their temperature resistance, renders possible local aggregation into atoms and molecules, and thus yields a special density which greatly increases the susceptibility to gravity. Therefore the density of the atmosphere of any planet depends only partly on its gravitative energy, and partly on the secondary condensation which takes place when the atmosphere becomes sufficiently dense to permit of chemical integration.

Thus a small sphere might be destitute of any but a very rare atmosphere, from its not being able to produce the density necessary to set up this secondary action. Such may be the case with our moon. Its atmosphere may consist only of the primary integrations of the matter of space, in a state too diffuse to become apparent to us. Here there

is a marked distinction between the state of condensation of the solid and gaseous surfaces. As globes increase in gravitative vigour this distinction decreases. It is much less declared in the earth than in the moon. In Jupiter, or in the Sun, it may be so reduced that no real distinction continues to exist. The atmosphere of the sun may be, or may become, so dense through gravity and pressure, and through chemical integration, that in this orb the three states of matter—the solid, the liquid, and the gas—may eventually shade into each other with no marked line of demarcation.

If, again, the earth cannot absorb its atmosphere, and remain denuded of an atmospheric covering, neither is it probable that it can dispose finally of its liquid covering. For the absorption of the water surrounding the earth must act to decrease the density of the atmosphere, by depriving it of its aqueous vapour. In such a case the tendency of the remaining atmosphere to greater condensation might bring the possible hydrogen which exists in contiguity with oxygen above their combining level to a lower level, and produce a new production of atmospheric water vapour. It is certainly conceivable that any loss of water at the surface might be thus compensated, and even that such a production of water vapour may occasionally occur now; balanced, perhaps, by a reverse action, as now hydrogen descends below the limiting level, now water vapour ascends above it.

In fact, the process of formation of the solid surface of the earth may have been through successive stages of development similar to that above described. As density increased the atmosphere partly became liquefied. Further condensation solidified this liquid, and a new liquid replaced it. The solids became more and more complex and dense, while successively new liquids appeared. Finally only the most volatile elements remained in the atmosphere, and these, in their turn, partly condensed into the liquid called water. This is also, by the slow process of refrigeration, approaching its solidifying point, and would long since have passed it but for the external heating influence of the sun. This liquid is also being slowly exhausted through absorption into the solid surface; but as it is composed of two of the lightest elements, which are likely long to continue abundant in a gaseous state, all such loss by absorption will probably be replaced by new production. We have water on the surface, water vapour in the atmosphere extending to a certain height, and beyond that height free hydrogen. Thus hydrogen as well as oxygen may extend through all levels, but

may be prevented from descending to a level which would bring it within the grasp of oxygen by some influence from the presence of water vapour, it descending only when the atmosphere is greatly denuded of its water vapour.

If now refrigeration of the earth's surface should become sufficient to solidify all its liquid water, or to convert all existing and all new-formed water vapour into snow and ice, what would result? Certainly an increasing gravitative vigour, and an atmospheric denudation which must be replaced by some form of new condensation. It is not inconceivable that, if the present atmospheric constituents were measurably exhausted, they might be replaced by other elements capable of yielding new cycles of terrestrial evolution. Yet if we are to judge by the apparent conditions of other spheres, it may be possible that hydrogen is the lightest available chemical element, and that a waterless sphere would be a dead world.

III. THE FORMATIVE POWER IN NATURE.

By Sidney Billing.

A CORRESPONDENT (H. B.) in your issue of April comments on the article "The Formative Power in Nature," written by me, and which appeared in the February number of your Journal, of which, I suppose, generally he approves, although "the arguments and illustrations are not new ones." I did not pretend to novelty in idea, or to originality; my intention was merely to bring together such facts as I deemed to be incontrovertible, and I endeavoured so to marshal them that they should present that outcome which common reasoning would assign to them,—with what success I leave to the judgment of your readers.

The subject in comment is large and varied, and may be considered as the vexed question of the day; it is only important because casual readers and half-thinking men are caught by the glitter of words, and are thus led away from the significance of the proposition, accepting too frequently

the theories advanced as the real outcomes and the matured conclusions of Science, when generally they are the baldest hypotheses. New theories crowd upon us; but when we find it advanced as a serious conclusion that every particle of matter in the universe is self-conscious, thinking, and sensitive, we are much inclined to use the talk of the showman, and enquire "What comes next, Mr. Merryman?"

As a general principle it is not my wont to indulge in new theories, or strive for originality; my effort generally is to state my proposition in plain words, addressing myself to the common sense of my readers rather than to the endeavour to excite their wonderment. New theories, too usually, present the very bathos of absurdity. One theory, now old, which at the present time is the very basis of Kosmic ideas, however extreme it may be in idea, meets with a general acceptance. The conflagration theory, with flaming hydrogen and nitrogen,—a world of combustion!—although based on the nebular theory of the great Kant and confirmed by the mathematical precision of the equally great Laplace, or rather I should say contemporaneously thought out by these great minds, and by the latter produced as a mathematical formula, is to my mind untrue and unscientific. The absurdity of such a Kosmic scheme is well illustrated by a very celebrated popular scientific lecturer: he accepts the scheme, and there was *no irony* in his idea when he wrote "Not alone the mechanism of the human body, but that of the human mind itself,—emotion, intellect, and will, and all their phenomena,—were once latent in a fiery cloud." To suppose the possibility of intellect being but an emanation from "a fiery cloud," even though the conflagration were general, seriously proposed, the assumption in itself is a *reductio ad absurdum*.* We know that all substances can be resolved into gases, but we do not perceive them as subsisting flaming elements. Another peculiar hypothesis, that of another distinguished physicist, is that life was introduced upon the earth by an atom from an exploded world. The wonder is not that such an hypothesis was conceived, but that it is said to be accepted by Prof. Helmholtz, a clear and acute reasoner: surely he would at the least have seen, supposing it were so, that the origin of life is not thereby accounted for; come from what or whence it may, its antecedent must have been a living intelligent energy. Great philosophers and great workers frequently, when they stray without the pale of their specialities, indulge in eccentricities

* *Vide*, for the author's Kosmic idea, pp. 19 to 24 "Scientific Materialism," &c.

—the idiosyncracy of great minds. Had H. B. carefully noted what I wrote, he would have seen that I did not suppose I was adducing anything new. I wrote "I am merely testing, &c., ... by the commonest phase of surface reasoning."

"The material philosopher counts his atoms, and decides the Kosmos is composed of units of matter, in its eternity combining cause and effect." "The physicist considers his conceptions as a summation of effects, and as an idealisation of his dream finds the bases of all things in eternal matter." The natural philosopher, in a purer ideal, "taking note of infinitesimal quantities, brushes them aside in the truer aim of disclosing the religion of Nature, wherein he finds an intelligence which man alone, of all created beings, shares." Nature, whether contemplated in her higher or lower phases, has the same cadence, harmony, symmetry, and sympathy, whether exemplified in a sand-grain or a world, and in the beyond, a providence exemplified in the laws of being, not supernatural, although supersensual.

H. B. thinks "I should have demanded the meaning of the word spontaneity," &c. There was no occasion to enquire what Prof. Haeckel meant by spontaneity; he explains it (this I should have thought H. B. would have known—he quotes as though he had read the work). Spontaneity pure and simple is *generatio æquivoca*, *i.e.*, the coming into being through a self-imposed and inherent necessity, without the action of any will, as Topsy came into being, *i.e.*, she "growed;" in fact exactly as Webster defines the word as derived from the Latin *spontaneitas*, "the quality or state of being spontaneous, or acting from native feeling, proneness, or temperament, without constraint or external force, *i.e.*, from an inherent necessity." Spontaneous has quite a different meaning: Lat. *spontaneus*, from *sponte*, free will, voluntarily. That I understand by spontaneous or spontaneity I have written elsewhere.* It is sufficient to say I do not mean *generatio æquivoca*. There exists no need "to hoist them (the monists) with their own petard;" they are always being "hoisted," but they always return to the charge, frequently with increased virulence. If the principles of our common reason have no effect, hard words are sure to fail.

Referring to a paragraph in which I say "Stratifications could only have arisen from a solidification of the gaseous substance which in amalgamation we term the ether," instead of stratification I should have said solid substance

* Scientific Materialism, &c., pp. 235 to 261.

(which was in my mind at the time I wrote). Stratifications arise, as a general principle, from the denudation of the rocks, sometimes modified by igneous action. H. B. says "he is uncertain whether he understands the author's meaning," and goes on to say "presuming" (as the printer makes him say) "that it is the lumi in germs," instead of, as it should have been, "the luminiferous ether" that is here alluded to, which he seems to consider as a gas more subtle than those composing our atmosphere. I would observe that this theory is a mere assumption," &c. He answers this phantom assumption which he has reared by another theory which is equally an assumption. *Passim* I may say the concluding paragraph of H. B.'s letter (on p. 243) is a complete mystification: whatever be his conception of the Creator or Creation, he should at the least have supposed that an act of creation was done once for all, not to be afterwards modified and adapted by *Him.* Whatever creation was, to my mind, the act was done once for all, self-containing and self-continuing; being stored with interior energy it became self-modifying. A tentative power, so far as the Creator is concerned, could never be conceived by anyone who has a true and real appreciation of what the Creator as God must mean, "who said be, and it was." These confusions arise, no doubt, from the attempt to reconcile in his mind Theology with Science.

It is not because to our perceptions there are different forms of matter (*i.e.*, elemental substances), that they were created in the forms which are presented to our perceptions. It is more than possible that they are the modifications and differentiations of one primordial substance by the interfusion of the forces (unless force and matter had one and the same initiation). The chemical properties of carbon and its extraordinary combinations (so to speak) lead to this inference, and this view gathers pertinence from the fact that Mr. Norman Lockyer resolved one of these so-called elements (if I mistake not, copper), proving it to be a combination.

Mr. Crookes has shown that there is a fourth state of matter, and probably a something beyond; therefore it would be easy to arrive at the idea "of a gas more subtle than that composing our atmosphere." If I were asked what my idea of the ether is, I should probably answer—a subtle something which permeates the universe, and proceeds directly from the will of the Creator, in which all things exist, and out of which worlds and systems of worlds, and all things which exist with them, are formed.

The luminiferous ether by substitution for the "lumi in germs" still leaves me at a loss; it is a phrase frequently met with, but what does it mean? If presented as the source of light (it neither bears nor produces) it is meaningless. The ether permeates all things; hence, if "*luminiferous*," there were no possibility of darkness—no night. All conceptions as to what the ether is must be purely conjectural. Balloonists assert that the higher they ascend the atmosphere the darker and colder it becomes; yet they have not probed it by more than one-tenth vertically. There is no vacuum. Were the ether the source of light or light giving, the higher the ascent the brighter the aspect. The sun is the source of light, but this light does not arise from the *heat* of the sun: were it so, the higher the ascent the warmer the atmosphere should be. Coldness and darkness are not very consistent with a *luminiferous* ether, nor with a *heat-emitting* sun.

The phrase luminiferous ether has grown into vogue because it has the seeming of science, and has been used by some scientific orator who delighted in words having more sound than significance, and hence adopted by others in the presumption of value; but whatever that be it is purely suppositious. It is doubtful whether the man who first connected luminiferous with the ether knew its meaning. There can be no question but that the sun is the source of both light and heat, so far as his system is concerned, by transmutation (*correlation*); as well it might be said that the agglomerated substances which coalesce to make the protoplasm are the *sources* of life, as to talk of the luminiferous ether as the *source of light.*

H. B. *surmises* the absence of gravity, as in connection with the ether, prevents its solidification. If it be not from the ether, from whence are derived the substances we know as matter, solid or gaseous? Some German philosophers appear to treat gravity and gravitation as distinct properties; the first referring to terrestrial substances and things connected with the earth; the latter in relation of sun with sun thus permeating the universe.

We know not what the ether is, whether a creation or what; but whatever it be, it is no doubt the nucleus—or I may say the seething-vat—from whence Nature draws her resources, and out of which all we know as terrestrial formations arose by condensations, coagulations, and *force* impulsions.

I do not think the system a good one which needlessly intrudes the idea of the Creator in a theological sense, or to

speak in a scientific article of what "Christians worship and adore." All men, willingly or unwillingly, entertain the idea of God, and all thinking men attempt to define him, because all such men desire to understand that which is the object of their faith. So far as I can understand or learn (my studies have been somewhat extensive) no man has yet accomplished that object. Dean Stanley says, "To Spinoza was vouchsafed the clearest glimpse into the nature of Deity." After a contemplation of this most momentous conception, man falls back on the comparative nothingness of himself, and finds how miserably small is the faculty he possesses when he endeavours to grasp this stupendous idea. No man by his reason can define what God is, nor where God is; no human reason can teach of his being or of his existence. We go to Nature, and there find order amid diversity, and homogeneity in seeming heterogeneity. We know that accumulated accidents do not constitute order: where order is there is always intelligent direction and superintendence; hence we infer that Nature had an ordinator, and that all we perceive must have been the result of that ordinator's will, combined with a maintaining power which may well be termed a providence. We see the machine, and infer that there is a machinist or creator. We see intelligent direction, and therefore infer that there is intelligence in the machinist. We see the exemplification of power, and we therefore infer that the machinist is powerful. We see an orderly maintenance and direction, and therefore infer the continual presence of the machinist. The corollary of this exposition is that the machinist is all intelligent, because all his works which we are able to examine are perfectly adapted to their particular placements, and of each to the other; that he is ultra-powerful, because the great and little —the floating mote which reflects the magnetic action of the sun, comprehended as light, and worlds and systems of worlds—are in his grasp; that he is ever superintending, because the universe is orderly administered,—*i.e.*, the universe is order. Thus we arrive at a Machinist or Creator who is omniscient, omnipotent, and omnipresent; further than this no reasoning will lead us.

In the Vedic poems of Chaos, or the beginning, we read:—"Nothing that is was then, even what is not did not exist then; what was it that hid or covered the existing? What was the refuge of what? Was water the deep abyss, the Chaos which swallowed up everything? There was no death, nothing immortal. There was no space, no life, and, lastly, no time, no solar torch by which morning might be

told from evening. That one breathed breathless by itself; other than it, nothing has since been. That one breathed and lived; it enjoyed more than mere existence; yet its life was not dependent on itself, as our life depends on the air we breathe. It breathed breathless. Darkness there was, and all at first was veiled in gloom profound as the ocean."*

The Chinese philosopher, Lao-tse, says—"Tào, if it can be named, is not the eternal one. The nameless one is the foundation of heaven and earth. He who has a name is the mother of all things. He who begins to create has a name." He further describes the unfathomable Tào:—"It strives not, yet is able to overcome. It speaks not, yet is able to obtain an answer. It summonses not, yet men come to it of their own accord. It is long suffering, yet is able to succeed in its designs."

These are the philosophies of India and China. What more do we know of the Infinite Supreme? Were this all we should have the cognition of Deity, but no realisation. Happily we have within us, by the ordination of the Creator, an invisible chain which connects the spiritual in man with that grand and eternal supremacy which creates, guides, directs, and maintains. We "have besides Reason two other organs of knowledge, Sense and Faith, neither subordinate to the other, but co-equal. Faith is that organ of knowledge by which we apprehend infinitude. The Infinite hidden from the senses, denied by reason, is conceived by faith underlying the experience of the senses and the combinations of reason."†

All that we can conceive of Deity is consolidated in faith, that inner action of the mind which compels to reverence and duty, but which in abuse becomes superstition and intolerance. Man cannot escape a faith; "it is a conviction implanted in the human mind of something ineffable."‡ Lord Amberley says "Religion formulated in intelligence postulates its position as fixed and final. It no sooner appears than a formula is instituted against which it is continually protesting. The attempt is always made to confine it within a set of dogmas. Sooner or later the religious sentiment bursts from the imposed thrall, but awaiting the new advent is another scheme of dogmas. This is the history of creeds in all ages of the world, and it is not the less true that the deepest hostility to theological systems is inspired

* Hist. Sanskrit, litt. MAX MULLER.
† Science of Languages, MAX MULLER.
‡ JUSTIN MARTYR.

by the very sentiment to which those systems seek to give a formula and definite expression.*

I have been led into a digression because I saw that, if H. B. did not understand a plain statement, others probably might fall into the same error. Theology and Science are exactly opposite in their nature, their only analogy being the dogmatic assumption of their professors. Whilst religion knows no creeds; it is universal in its application—the parent of faith and moral duty. It induces contemplation whereby man can discern that God unknown to our reason, is verified by faith, and in the wondrous formations of Nature reads as in a book penned by the fingers of a Supreme Intelligence. Thus Nature, in the unison of her harmony, is enthroned in divinity of which the universe is the embodiment, finding a reality in the illimitable all, that which was and that which is, the sole Eternity—Intelligence which rules all things, perfects all things, and exists in all things, personified becomes that we know as God.

I do not know what importance H. B. attaches to his concluding sentence when he talks of "the original fundamental form of matter." If he would tell the scientific world what is force and what is matter, he would do more service than by reading an article and interposing his own assumptions as the author's conclusions. Elsewhere I have very fully given my ideas as to force, matter, and the economy of Nature. In an article of limited space it is impossible to state the grounds for the conclusions, and I do think it wiser for persons thoroughly to understand an author's meaning before they introduce their own assumptions as explanatory of a text which they misapprehend.

PS. It were more courteous, when a comment is made on an article signed by the author in full, if the commentator signed his name in full. In future I shall take no notice of comments on articles signed by my full name, unless the commentator does the same.

* Analyses of Rel. Belief. The above is the sense, but not the exact words.

IV. HUMAN COMPLEXION AND ITS CAUSES.

THE varying colour and texture of the human skin have long been a vexed question among anthropologists and ethnologists, and the common explanation, which ascribes all these differences to latitude, breaks down on the most moderate scrutiny. It is easy to say that the Negro is black because he lives on the Equator, and that the Moor, the Spaniard, the Frenchman, the Englishman, and the Norwegian are progressively fairer of complexion as their dwelling-places approach the Polar regions. But if we look to the western side of the Atlantic we find no such series of changes. The aborigines of America, whether in arctic, temperate, or tropical regions, vary little in colour, and it may safely be said that under the Equator, in Brazil, they are not the darkest. Even in the Old World we meet with facts quite inconsistent with the "latitude" theory. The Swede and Norwegian are very light-coloured, but to the north of them live the swarthy Lapps and Greenlanders. The Maori, living in a climate not unlike that of Britain, is as dark as the natives of Tahiti or Hawaii within the tropics. In Europe we might even be led to suppose that colour was a question of longitude. If we travel from France eastwards, we find in Germany a decidedly lighter complexion prevailing. But if we continue our journey eastwards we find dark hair and eyes, and even a dark tone of complexion, among the Bohemians and Poles. If we enter Asia we find the yellow Mongol race varying little in tint from the South of China, and even from Anam to the frontiers of Russia. These instances, which are given merely as specimens selected out of a great number, are surely more than enough to show that human complexion is not a function of latitude.

Another theory is that the inhabitants of mountainous regions are fairer than those who inhabit the plains, the latitude in each case being the same. We see scant foundation for this view. The Norwegian mountaineer is no darker than his neighbour the Swede, and both of them are, if anything, fairer than the Russian, the native of one of the flattest countries in the world. In the British Islands dark eyes, hair, and complexions are quite as common in the mountains of Wales and Scotland as in the most level parts

of England. The inhabitants of the Mexican table-land are as brown as those of the *tierras calientes.* "The Aymaras and Quichuas of the Peruvian Andes are darker than the Yuracaras of the forests to the eastwards.

A further supposition is that the more carnivorous races of mankind are fairer than their vegetarian neighbours. In opposition it may be urged that the Red-skins of North America, who subsist almost entirely upon the produce of the chase, are darker than the European immigrants who have almost entirely displaced them.

All these attempts at an explanation of the facts of complexion being therefore quite unsatisfactory, there is need and room for a new theory. Such a one has been propounded by Mr. J. M. Buchan, M.A., in a paper read at a meeting of the Canadian Institute of Toronto,* and is decidedly worthy of a careful examination. The author recognises two factors, well known to have a great influence upon animal and vegetable life, temperature and climate. He arranges climates under five heads:—

I. Arctic.
II. Temperate moist.
III. Temperate dry.
IV. Tropical moist.
V. Tropical dry.

Before proceeding to examine the kind of skin best adapted to these different climates, he gives a brief account of the epidermis and of its colouring-matters. Here he takes occasion to remark that "the deeper the shade of the pigment the more rays will it reflect, and the more effective will it be as a protective agency. On the contrary, the lighter the shade the more light and heat will it permit to enter the body."

Now except the pigment of the skin possesses properties totally different from all those with which physicists have been in the habit of experimenting, this is a most perplexing statement. We find, by direct trials, that the darker any surface the more readily it absorbs radiant heat. Water placed in a tin vessel coated with lamp-black will rise to a higher temperature on exposure to the sun than if placed in a similar vessel painted white. And, in virtue of the very same principle, water in a black can, if left in the open air on a frosty night, will freeze more rapidly than if it had been

* *See* Popular Science Monthly, May, 1880.

put in a white can. Just the same is the case with light. We call a surface white when it reflects all the incident rays, and black when it absorbs them all. We are not aware that the difficulty has ever been fairly met—why a colour should be advantageous for the skin in a hot climate, when for everything else which we wish to preserve from overheating it is found disadvantageous.

To proceed: Mr. Buchan contends that in an arctic climate transudation is accelerated. "The frosty air, raised in temperature many degrees by contact with the body, becomes very dry, and greedily drinks up its moisture." Thus the temperature of the system is lowered, and at the same time the person suffers from excessive thirst. Hence a very thick skin will be needful, which, though containing little pigment, will produce a swarthy effect.

By a "moist temperate" climate the author means one like that of Western Europe, where the range of temperature is small and the air contains a large amount of water in solution. Here perspiration is reduced by the inability of the atmosphere to take up much moisture. The cuticle is constantly thin, and the complexion clear and fair. In "dry temperate climates" the air is usually dry, the summers hot, and the winters severe. Hence a thick cuticle is needed "to prevent the too rapid withdrawal of the fluid contents of the capillaries by the dry air," whilst the presence of a pigment "suitable to the intensity of the sun's rays" produces various shades of yellow and brown.

Under a "humid tropical climate" the author ranks such as have no dry season, with a high but steady temperature. The power of the sun's rays will be so diminished by the abundance of vapour that the inhabitants will not require the protection of so dark a pigment as the natives of other tropical regions. A thin epidermis will be needed to facilitate perspiration. Hence the natives of these equatorial regions should be distinguished by relatively fair complexions. In such tropical climates as are rainless, or possess well-marked dry seasons, the rays of the sun will descend with full power, whilst at the same time a considerable degree of cold will be experienced before sunrise. To meet both these extremes a thick outer skin will be required, and we therefore find in such regions the blackest men and the thickest skins.

A great part of the author's contention must be at once conceded. In dry climates, whether cold or hot, and in such as undergo great vicissitudes of temperature, a thicker skin is undoubtedly required than in regions where the air

is humid and the range of the thermometer small. This law is plainly stamped on the vegetable world. But when we come to the consideration of colour we meet with difficulties which cannot be overlooked. Let us take, in the first place, the moist tropical climates, the regions situate on or near the Equator, including, of course, the Valley of the Amazon, a certain portion of the African continent, Sumatra, Borneo, and New Guinea. Here, according to Mr. Buchan, the natives should have a thin cuticle and a relatively fair complexion ; yet in this equatorial zone we find a very considerable diversity. We have the copper-coloured native of South America, and the black negro of Congo and the Guinea Coast. Now the aborigines of equatorial Brazil, as we are told by so experienced an observer as Mr. Bates, bear their native climate not merely worse than the blacker and thicker-skinned negro, but even worse than the European! Again, we should think, on Mr. Buchan's theory, that, *e.g.*, an Englishman, with his thin cuticle and light complexion, ought to bear the climate of the Gold Coast better than the dry tropical or semi-tropical regions of Australia,—which is very far from being the case. The author remarks that "there are blacker men in New Guinea than in Borneo and Sumatra." Now all these islands lie in the humid tropical region. According to Mr. A. R. Wallace the climates of Borneo and of New Guinea are exceedingly similar, warm, constant, and humid. Why then should the natives of New Guinea be blacker than those of Borneo? Why do the latter differ in complexion from those of the Gold Coast, or of equatorial Brazil?

As regards the moist temperate regions there is one very significant fact mentioned in Mr. Buchan's favour. The north-western coasts of North America, including British Columbia and Alaska, approach north-western Europe in their meteorological character. The air is humid, the temperature constant and—for the latitude—high. The annual mean heat of Sitka is higher by 2 degrees than that of Quebec, which lies more than 10 degrees farther to the south. Here, accordingly, the aborigines have complexions not very different from those prevalent in Southern Europe. Fair hair, ruddy cheeks, and light eyes are not uncommon. But if we consider the climates of Tasmania and New Zealand, not very unlike those of Western Europe, and certainly mild, moist, and fluctuating little, we find a discrepancy which the theory does not explain. According to the most trustworthy accounts the aborigines of Tasmania, now extinct, were as dark as, if not darker than, those of the

mainland of Australia, which belongs to the dry temperate and dry tropical regions.

In the Polynesian Islands we find black and light brown races living in climates which differ respectively very little, if at all.

The dry tropical regions afford further difficulties. Torrid and sub-torrid Africa, outside the equatorial belt, presents a black population; whilst that of tropical China, Annam, &c., is yellow, and that of Mexico and Southern Brazil and Bolivia brown. Why these differences in regions all hot and dry?

Many of these difficulties may doubtless be solved by taking into account the migrations that have taken place. A race may have changed its seat, and not yet have assumed the complexion most in harmony with its surroundings. Thus the aborigines of South America may, as Mr. Bates supposes, have arrived from a colder country, and, unless they are previously extirpated, they may develop a darker complexion. It is even possible that the white inhabitants of the United States and Canada, were it not for the constant influx of European immigrants, might assume a complexion more and more assimilating to that of the Redskins. But on these gradual effects of climate we are still very ignorant. Europeans who spend their lives in tropical or sub-tropical countries are found to be considerably darkened; but their children seem in all authenticated cases to revert to the ancestral type. The Arabs, however, who as members of the Semitic race are certainly not black by origin, are said in Nubia to vie in colour with the most jetty negroes. It is even said that there are black Jews on the south-western coasts of India. If this statement is capable of verification it is of the more value, as the Jews everywhere keep aloof from other races, and no influence of mixed blood need here be suspected.

A curious circumstance is that in many civilised countries the complexion of the population has darkened within historical times, even where there has been no immigration of dark races at all adequate to effect the change. The oldest records describe the populations of France, Germany, and Britain as fair-haired and of light complexions. The two latter countries especially have received an abundant influx of population from the north, and from the south but little. Yet in Germany the more or less dark-haired individuals form a respectable minority, in Britain probably a majority, whilst in France light- or red-haired persons are decidedly exceptional.

From all these circumstances we should argue, not by any means that Mr. Buchan's theory should be abandoned, but that we are here in presence of a "residual phenomenon"—of a something over and above what may be accounted for by temperature and degree of atmospheric moisture, and which invites further research.

V. CHEMICAL SHAMS.

By J. HEPBURN DAVIDSON.

> CAM.—Was he not held a learned man?
> WOL.—Yes, surely.
> CAM.—Believe me, there's an ill opinion spread then, even of yourself, Lord Cardinal.
>
> *King Henry VIII.*

IN travelling through this vast world of toil, turmoil, and ill-feeling, we cannot help, as sufferers and on-lookers, feeling ashamed of some of the actors who play a leading part especially in Science, baffling the honest endeavours of those who are both morally and intellectually their betters, but have not yet secured a high pinnacle of position.

Academicians, Fellows of illustrious Societies, and heads of Science and Art Departments, make it one part of their business to pounce down upon the unwary scientist who fails to pay them due homage. How many men of merit are still suffering from dominant cliques the very same treatment which Lamarck met with from Cuvier, and Wolff from Haller! Who could not name a few such? A little bird once flew to a certain chemist, and chirped in his ear that he would have been elected a Fellow of the Carolinian Society had he only behaved more respectfully to Professor * * * * * *!

All this is the more unjustifiable because we fancy ourselves living in a free land, not a frank-land,* or land of serfdom, as of old. Yet there is a farm not one hundred

* "In the stye of this most bloody boar
My son, George Stanley, is frankt up in hold."

miles from the Albert Memorial where serf-chemists and serf-scientists in general are hatched in numbers, and sent out over the United Kingdom.

The serf-chemist contributes largely to the general amusement of youth. His display of fireworks and gaudy show of apparatus on the lecture-table do not fail to fascinate the juvenile eye. The roar of his hydrogen and oxygen cannon, as well as the roll of his matter-of-fact voice, with his general suave demeanour, have a powerful effect on both youthful and adult audiences, who look upon him as a prodigy of learning. A curious fact happened at one of those popular science lectures. The orator, in that polysyllabic dialect which mystifies the generality of his hearers, was illustrating the mode of producing hydrogen, as well as putting forth in learned garb the chemical theory of its liberation from sulphuric acid and zinc: he took the generator most gracefully in his left hand, and introduced with an ornamental sweep of the right a few pieces of the zinc, afterwards adding a more than sufficient amount of sulphuric acid at the highest specific gravity. Our lecturer then, with an air of confidence, corked the flask; the cork of course was perforated, and a piece of glass tube, drawn to a fine point, inserted. The apparatus was shaken vigorously, but no appearance of hydrogen! A look of mixed anxiety and chagrin passed over the pseudo's face, when a stentorian voice from the audience exclaimed "Stick in yer water, mon." Vulgar though the voice, its owner evidently knew more than the lecturer. Our serf had by this time recovered himself, and quietly said "I beg pardon, gentlemen; I had the full intention of introducing the water at first, but a new idea struck me, and I wished to verify it!" The next and most telling part of the lecture was the attempted illustration of the musical sounds caused by hydrogen. Our lecturer, having secured a length of combustion tubing, applied a taper to the hydrogen jet; but the result was a general explosion, the air not being completely expelled from the generator, and the acid was sprayed most effectually over the lecturer's coat, which in a short time showed that beautiful colour so often produced by sulphuric acid, and admired so much by pseudo-chemists in general.

It is humiliating to the scientific world, if we consider the amount of money annually spent in keeping up an Institution professedly to furnish the United Kingdom with properly qualified men, to find it sending forth a class of superficials who—after the magical passing of an examination—parade before us as certified science teachers and

guaranteed analysts. Nor are they slow at insulting and trying to cackle down every accomplished chemist who comes in their way, except he is connected with the farm aforesaid.

I know of an instance which cries seriously for the sympathy of scientific men, and which would call down public indignation if properly understood. A supposed impartial committee sent to inquire into a case of injured merit, actually sided with the oppressors as being the more influential party. After a series of gastronomic performances, in which the committee exhibited the "Science and Art" of eating, and after their personal vanity had been settled by dexterously managed fawning, a decision was then given against the injured party, who thus fell a victim to the jealousy of men professionally his inferiors! However, committees are but mortal, and are endowed with poor human natures, liable to wither when the conscience is dead.

Before leaving the serf type I must treat of one in particular, who has opened his palace of chemical entertainments in the remote regions of Scotland. This gentleman made a speciality of agricultural chemistry. After a very short period of incubation, at the English farm already referred to, he returns to his native soil, dons the broadcloth, and lectures to a set of shock-headed youths; thereby he acquires the name of a "clever mon." As his fame rises conceit keeps pace. Inspired by this conceit he encounters the educated and also the ignorant farmer, and astounds them with his learned, novel, and technical terms, in place of the plainer names which they are accustomed to hear. By dint of this fire of new verbiage he succeeds in making them believe that he is superior to his seniors and is versed in all the latest analytical processes, and thus secures samples to *analyse*. This *tyro* actually waged warfare against two well-known chemists, one of whom treated him with silent contempt, and the other carried on the contest. Although the second gentleman convinced men who knew their profession that the tyro was wrong, the latter still held his point with the most dogmatic assurance, earning the laughter of parties who watched the controversy. The result of this war was his losing caste in the eyes of many of his scientific brethren.

Let us hope our northern oracle will, like his national poet's "Nickie Ben,"—

"Tak' a thocht and mend."

The *medical* public analyst is another gentleman who generally stands high in popular estimation. In the eyes of the many the fact of his being a "*Doctor*" guarantees his abilities as a chemist. If the public only knew that the subject of their adoration had enjoyed only a six months' course of chemical lectures, at some University or College, during the winter session, and three months' practice during summer in qualitative analysis, and that as a rule very superficially gone through,—as very often students are not allowed the use of the regular laboratory, but extempore benches are fitted up in the lecture or tutorial room, and then only an hour is allowed for the class each day unless the pupil wishes to enrol himself for the regular laboratory curriculum,—what, then, would the public think, especially the trading community? Here, then, is our analyst, empowered to examine a sample of milk, sugar, or coffee, and the dealer is liable at any time, on the strength of his results, to be convicted and mulcted in a heavy penalty. What would our decent tradesman say if he understood what is, in contrast, the training of a really qualified chemist? He would say it was a piece of quackish presumption on the part of the medical man to hold such a post. We cannot, however, brand the whole medical world as not being trustworthy chemists, since some of our most able scientists belong to that honoured faculty. There are several—in fact, a great many—who after graduating almost entirely abandon practice, and give their whole heart and soul to scientific pursuits, looking upon their professional degree as a resource for a rainy day, and as the guarantee of a high class University education. There is one plea for the medical *pseudo* analyst, which is that no thoroughly qualified chemist will take the billet in the district where the medical man resides, as the retaining fee may be a miserable pittance barely sufficient to supply reagents, and the fee for each analysis perhaps as low as two and sixpence per sample; which, taken together at the year's end, would be barely sufficient to pay the rental of a laboratory and cover accidental breakage of apparatus. Fortunately the authorities of different towns are beginning to see the necessity of having a qualified chemist, as several dubious convictions have lately happened, and the idea current among private chemists who have analysed duplicates of the samples was that the defendants were innocent. One qualified chemist can now have his laboratory in the city, and yet be public analyst for several provincial towns, thereby leaving the *pseudo* medical analyst to his legitimate profession.

The chemical technologist—or, as he is commonly called, the works chemist—is the most down-trodden and injured individual in the profession. He is, in other words, treated as a mere analytical machine, subject to the control of often an ignorant master whose thick intellect cannot grasp the simplest rudiments of the science. In fact the master is a "rule-of-thumb man," and although his professional man makes an improvement it is pooh-poohed at through the routinism of his employer. It is the fate of many a sound chemist to be thus placed. A sample may be sent up to the laboratory, and the result "wanted without fail in two hours," though the analysis, if carefully done with the utmost expedition, would, we will say, take six hours. What is the result ? Our honest, well-meaning chemist, who hates the stain of inaccuracy on his name, and looks to a *bona fide* character, falls into disgrace as an inefficient analyst. Put the *pseudo* chemist in his place, he receives the sample to be analysed with the coolest of manners, makes his weighings, and proceeds. If it is a mineral phosphate, he does not evaporate his acid solution to dryness, to expel hydrofluoric acid and render his soluble silica insoluble; he filters the silica off roughly, and, after a slight washing, proceeds to precipitate his phosphate of lime with a large excess of ammonia, thereby bringing a certain amount of foreign lime down mechanically with his precipitate. He does not over-wash this precipitate, but places it—still saturated with ammonia—on the top of his copper water-bath. When nearly dry enough for ignition the filter is found to be dyed with a magnificent blue colour, which is neither more nor less than the copper dissolved by the ammonia. He ignites and weighs as pure tricalcic phosphate. In reality it is contaminated, perhaps to a high percentage, with oxide of iron and alumina, as well as oxide of copper from the water-bath. He draws out his report, and hands it to his employer a quarter of an hour before the time specified, and thereby gets the fame of an exceedingly clever fellow, because he is expeditious, and has given good (high) results which are to his employer's interests. The honest chemist cannot give such good results, neither can he do it in the same space of time, as his conscience forbids him to report oxide of iron and alumina as tricalcic phosphate, the removal of these bodies for the determination of phosphoric acid requiring some hours standing.

The reader may ask, what is the way to clear the atmosphere of our laboratories of the various types of *pseudo* chemists? Much of the mischief is effected by parents

pushing their sons into professions for which they have no natural aptitude or inclination. A child's development should be carefully studied, and the profession he is to follow should be deduced from his powers and his character.

As to professional jealousy, departmental tyranny, and the ignorant interference of employers, they will continue to the world's end. Would that our leaders would take Michael Faraday as their model, and, when hearing expositions of his merit, ask themselves in how far they are actuated by his spirit? He was a man loving Science for its own sake, rather than for the influence or reputation it brought him; loving, too, to give a helping hand and a kindly word to his brethren, and ready to recognise new truths even if uttered by the humblest.

VI. EXPLOSIVES.

IT seems probable that the science of Explosives will rapidly develop itself, and that public opinion, excited by late events, will have to pronounce on the restrictions it requires. Our present protection lies in the provisions of the "Explosives Act" of 1875; and experience suggests whether, at least in its exemptions, it does not require immediate revision. The purpose of the Act is to interpose the security of a license, and with it the supervision it presupposes; but the words of exemption, in Sect. 4, are that "the Act is not to apply to a small quantity for the purpose of chemical experiment, and not for practical use or sale." The six years since this Act was passed have changed the incidence of these words as words of exemption; and the advance of explosive science, it would seem, will practically put the preparation of many explosives out of reach of the Act, and out of control, by absolving them from the necessity for a license under this exemption clause. "A small quantity" is a term of proportion; it is relative; what is a small quantity for one purpose is large for another, and the contrary. A mere laboratory experiment is one thing, an experimental trial of an explosive is another. A tea-cup or a thimble might suffice for the one, vessels of capacity would

be required for the other. Yet fulminating gold and fulminate of mercury need only a very minute quantity to produce a frightful explosion ; nitro-glycerine, as we have lately too well known, requires but a small quantity, and would be covered by this Section 4. On the other hand, since the introduction of the immense modern cannon, it is necessary to make powder with very large grain ; the "pebble-powder" now in use is larger in grain than hazelnuts, and an experiment for its composition, though not manageable with "a small quantity," would yet be within the *ipsissima verba* of the Section as "a chemical experiment." Or such a thing as the new Russian war-powder, so different in composition from our "Waltham," will probably give rise to many "chemical experiments ;" so, too, dynamite and gun-cotton, and other less known compounds.

The moral from all this is that the exemptions clause of the Act, with its indefinite term "a small quantity," and the misapprehension of which that is capable, should be replaced, possibly, by some measure of weight, or bulk, or volume, and that so indeterminate a phrase as "chemical experiment" should be narrowed by interposing at least the word "laboratory."

Perhaps still better would it be that no exemption be allowed, but a license required in all cases. It is more and more evident that the words "for practical use or for sale" do not reach the requisite restriction, especially at a time when England is charged with harbouring a certain class of explosives experimentizers.

It would have, however, to be fully considered whether these indefinite exemptions of the Act are not even yet preferable to a scale of measurement, which might be either too large for public safety or too small for any useful purpose. In other words, whether definition may not be inexpedient, and every case should be determined on its own merits by the evidence of experts. If it would be unreasonable to fetter chemical students, preparing for examination, with the necessity of a license, it would be worse, and it would be dangerous, to absolve the inventors of new projectiles from its safeguard.

ANALYSES OF BOOKS.

*The so-called Understanding of Animals, or Animal Instinct: a Popular-Scientific Study.** By Dr. Leopold Schutz, Professor at the Seminary for Priests at Treves. Paderborn: Ferdinand Schöningh.

Having for many years paid close attention to animal psychology we feel bound, in addition to our own observations and reflections, to take into account the writings of all men of science who have made this matter the subject of serious study. We were therefore very happy on receiving, through the courtesy of the publisher, a copy of Dr. Schütz's work. Our satisfaction was not the less, but rather the greater, because the first glance at the title-page convinced us that the learned author had arrived at conclusions widely differing from our own,—which, however, we are perfectly prepared to surrender if they can be proved incompatible with facts.

In the Preface we are at once confronted with a decided novelty. The irrationality of the lower animals is presented as something very like a dogma of the Christian Church. Those who uphold the mysterious notion of instinct are "combatants for pure truth and genuine science," whilst those who, like ourselves, consider the difference between man and beast as one of degree rather than of kind, are pronounced Materialists, "enemies of the Christian faith," and "mercenaries of a preconceived opinion or of a spurious illumination. Against these expressions, or rather against the vein of thought underlying them, we must earnestly protest. Had Dr. Schütz, in accordance with his duty, made a conscientious examination of the literature of the subject, he would have found that there is no necessary connection between the Instinctarian doctrine and Theism or Christianity, and in like manner that the belief in animal rationality is nowise a consequence of Materialism. Among the many writers utterly free from any leanings to Atheism, or to a denial of revealed religion, but who have been unable to shut their eyes to the overwhelming evidences of animal rationality, we may cite the late Archbishop Whately. He writes:—"It is quite clear that if such acts were done by men they would be regarded as an exercise of reason, and I do not know why when performed by brutes, evidently by a similar process, as far as can be judged,

* Der sogenannte Verstand der Thiere oder der Animalische Instinkt; eine populär-naturwissenschaftliche Studie.

they should not bear the same name. To talk of a cat's having instinct to pull a bell when desirous of going out at the door would be to use words at random."

Agassiz, also a Theist and a Christian, holds ("Natural History United States, I., i., p. 60) "that it is impracticable to draw any definite boundary between the faculties of a young child and those of a baby chimpanzee."

Cuvier, who is even accused by certain modern thinkers of an over-strained deference to theological tradition, says of the brutes:—"Leur intelligence exécute des opérations du même genre"—*i.e.*, as human actions.

Milton, an excellent logician, a profound student of and a firm believer in the Scriptures, puts in the mouth of an archangel these words—"They also reason not contemptibly."

Prof. Max Müller—no friend, be it remarked, of the doctrine of Evolution—writes, in his "Lectures on the Science of Language" (i., p. 402):—"Instinct, whether mechanical or moral, is more prominent in brutes than in man, but it exists in both as much as intellect is shared by both."

Lord Brougham, a writer on Natural Theology and editor of Paley, says, in his "Dialogues on Instinct" (Dialogue IV.):—"I know not why so much unwillingness should be shown by some excellent philosophers to allow intelligent faculties and a share of reason to the lower animals."

Such examples of Theists and Anti-Materialists, who refuse to explain the actions of brutes by the catch-word Instinct, might be multiplied indefinitely. On the other hand, everyone must have met with Atheists who reject with the utmost scorn the notion of reason in the lower animals. We regret, therefore, to be compelled to say that Dr. Schütz has put himself out of court by his Preface, which is either a proof that his acquaintance with the subject is deficient in thoroughness, or else a deliberate appeal to the *odium theologicum*.

The author's contention is summed up by himself in five so-called facts. He declares, first, "The animal does not reflect, does not need to reflect, and indeed never does reflect." This fact, we reply, is a gross error. Animals have in many cases been observed to reflect or consider,—to take extraordinary steps and measures under especial circumstances; they arrange stratagems available only at some particular time and place. Rats cannot long be caught by means of the same kind of trap. Birds avoid a scarecrow for a few days, and then discover its harmlessness. Prof. Leukart (Graber, "Organismus der Insekten," p. 249), in order to keep away ants from a colony of Aphides, besmeared the stem of the plant all round with tobacco-juice. These little creatures were not long checked by the abomination. They carried up grains of earth, and built a causeway upon which they could pass and repass at pleasure.

Prof. Gredler, of Botzen ("Der Zoolog. Garten," xv., p. 434),

gives an instance where ants got at some sugar purposely placed in a vessel hung by a string from the transom of a window-frame, by running up the woodwork and down the string. Afterwards they entirely abandoned this tedious route, a few of their number entering the vessel and throwing the sugar down to their comrades below.

A dog, set to fetch two hats, has been known to pack one inside the other. Such real facts prove Dr. Schütz's "erste Thatsache" to be a delusion.

The author's second fact is that "Many animals surpass man by the prudence and sagacity of their actions. That this is the case, and that the animals concerned still remain below the level of the human understanding, is similarly to be explained on the hypothesis of animal instinct." This fact, in so far as it is a fact, and where it does not find its explanation in the superior delicacy of the outer senses which many of the lower animals are known to possess, is merely what we observe among individual men. A B may be far below C D in the general level of his intelligence, but yet in some particular sphere of activity may far surpass him in foresight and sagacity.

The third assertion is that "The brute requires no instruction." This is simply incorrect. (*See* "Journal of Science," vi., p. 362). Old animals of every kind are more wary and cunning than young ones, as every close and conscientious observer can testify.

The fourth fact is that "The life of animals is non-progressive. How should an animal exceed the performances of its parents and forefathers, or fall short of them?" Here again we find palpable error. Had Dr. Schütz been either an observer or even a careful reader he could not venture upon such an assertion. Mr. Wallace ("Natural Selection," p. 227) shows that birds alter and improve their style of architecture according to circumstances. Dr. C. Abbott informs us that the common sparrow, introduced into America from England, has learnt to construct warm and commodious roosting-nests for protection in the severe winters. It is scarcely too much to say that this single fact suffices to overturn the theory of instinct in the traditional sense of the term.

Fifthly, and lastly, comes the assertion "The brute has no language." This also we must pronounce an error, as far as the higher animals are concerned. The instances where domestic animals have understood and acted upon remarks made by men, though such remarks had in them nothing of the nature of a command or a call which such creatures had been trained to obey, are numerous and perfectly authenticated. Now it is inconceivable that a being totally devoid of language, and therefore unqualified and unaccustomed to receive definite communications through any such channel, could understand the language of man.

There are, no doubt, animals literally dumb, devoid of sound-organs and of auditory appliances, and therefore incapable of mutual communication through the sense of hearing; devoid also of antennæ or feet, which might subserve a language of signs or touches. Between the absolute no-language of such animals and the rudimentary speech of birds and Mammalia there is a greater divergency than between the latter and the languages, *e.g.*, of the Veddahs of Ceylon.

We cannot help feeling some surprise that a work like that of Dr. Schütz should appear at the present day, especially in Germany, where accurate observers in Natural History are so abundant.

The Natural History of British Fishes. By Frank Buckland. London: Society for Promoting Christian Knowledge.

This work is intended not merely as a treatise on fish-lore, but as a manual of the art of fish-raising, The author rated highly, perhaps over rated, the importance of fish as an article of diet, and he exerted himself long and ably on behalf of the propagation and protection of such species as are particularly useful. Far be it from us to deny the value of his labours. Still, it seems to us that no possible increase in the multitude of food-fishes will make them fairly available for the great mass of the nation unless a scheme is devised for crushing out the middlemen who have seized upon the traffic, robbing alike the producer and the consumer and keeping up a system of artificial prices sometimes by dint of destroying whole cargoes.

The first thing which strikes us in the book is the account of a Nottingham "worm-farm" which sends to London 400,000 worms annually! The author believes that two young worms are sometimes produced out of a single egg.

Sewage, Mr. Buckland shows, is not necessarily deadly to fish. He states that "immense numbers of bleak can be seen at Oxford, at the point where the town sewer joins the Thames near Folly Bridge," and considers that they do an "immense amount of unpaid labour," doubtless by eating the putrescent solids. He observed the same fish also at the mouth of a sewer at Shrewsbury where the water was inky black from waste dye.

The viviparous character of the Blenny (*Blennius zoacces*), is a curious feature. Mr. Buckland recommends the young as excellent objects for the microscope for showing the circulation of the blood. The bull-head, it appears, sometimes proves fatal to king-fishers, as the spines on either side of the gill covers stick in the throat of the bird and choke him. Concerning the chub we read this singular passage:—" Why a chub has such a remark-

able skeleton I know not, and I should be much obliged if any of my readers could find out why the chub requires such a complicated system of bones." We quote this remark as characteristic of the author's vein of thought.

Feeding some tame cod-fish with a variety of matter he offered them a dead viper. when they all swam away! The following passage is significant:—"There seems also to be among fish, as among men, what the people in India call caste; that is to say a meeting of class A with class Z strikes a note of discord which no amount of the so much vaunted education of modern days will create into a concord." The conger eel Mr. Buckland thinks may have given rise to many of the stories of sea-serpents. Why is it, by the way, that in the south of England, the conger and the halibut are considered inferior to the cod, which, sauces apart, has as little flavour as a boiled dish-cloth?

On the "balance of life" (p. 73) the author over-balances himself. He tells us that "carnivorous animals have few at a birth, herbivorous animals many." We always thought that a cow, a ewe, or a goat never produced as many young at a birth as do the dog, the cat, or the semi-predaceous sow.

The gudgeon, we are told, are very fond of living in sewer-water, which would be immediately fatal to a trout or a salmon.

We find an abstract of the recommendations of a commission appointed in 1879 to examine into the herring-fisheries of Scotland. One of their conclusions was that "the Sea Birds Preservation Act, protecting gannets and other predaceous birds which cause a vast annual destruction of herrings should be repealed in so far as it applies to Scotland." Here is the difficulty in protecting animals of any class. What seems right from one point of view is objected to when considered from another. On p. 120 is the statement that nearly all the herrings taken in the Scotch fisheries were exported to Protestant countries, whereas the takes of Cornish pilchards were exported to Catholic countries. Mr. Buckland adds "there must be some good physiological reason for this curious fact!" A little further, in a chapter on the lamprey we meet with this singular sentence:—"On the Loire, as at Gloucester, they make them into pies, and are said to be exceedingly good."

The common stories about the longevity of the pike are dismissed as fabulous, though it does not appear upon what evidence save "improbability." Concerning the attendance of the pilot-fish (*Naucrates ductor*) upon sharks, Mr. Buckland suggests that its object is very probably to pick parasitic vermin off the shark's body. In the chapter on the sole we meet with a fact not generally known:—"Young plaice and soles when first hatched out always swim on their edge for about a week, and in this condition have their eyes upon different sides of the head." The old tradition that the tench is the pike's physician is rejected, for the author, like Waterton, can be sceptical as well as credu-

lous. In this instance he adduces conclusive evidence that young tench are a successful bait for pike. The sections on the systematic management of fish-ponds and on the acclimatisation of desirable species of fish are exceedingly important. In short, the entire work is replete with most valuable matter ranging from acute and original observations on the habits and anatomy of fishes to useful cookery receipts. It is eminently readable and presents in full luxuriance the properties which endeared its author to a wide circle of friends.

We wish our task could end here. But Mr. Buckland unfortunately enters upon the philosophy of biology—a theme for which he was totally unqualified, and seeks to defend the old doctrine of individual, mechanical creation. Had he any new line of argument to bring forward we should have been most happy to give it our most serious attention. But the "Bridgwater" argument in which he indulges is to be regretted, since the easy refutation to which it is open plays into the hands of the materialist school. Thus he points to "above all, the enormous fertility of fishes useful as food to the human race." If so, what is the inference to be drawn from the "enormous fertility" of animals hurtful to the human race? Further, it is by no means absolutely proved that man is adapted to an animal diet. There are those who contend that he was designed to support himself upon a purely vegetable regimen, and that by adopting carnivorous habits he has brought upon himself many evils, physical and moral. Still more to be regretted is the insinuation that "certain modern ideas of creation" are prompted by "pride of intellect," which cannot humble itself enough to accept on faith itself the fact that "The sea is His and He made it, and His hand prepared the dry land." Does it yet require to be shown that this is an utter misconception of the Evolutionist point of view?

The Ventilation of Dwelling-Houses, and the Utilisation of Waste Heat from Open Fireplaces. By FREDERICK EDWARDS, Jun. Second Edition. London: Longmans and Co.

WE have here an interesting and able contribution to the literature of a very serious subject. Ungenial seasons and dull trade are forcing increased thrift upon all classes, and it is becoming doubtful how long we can afford to indulge in our twin national extravagances of "cheerful" fires and "plain" cookery. Furthermore, the growth of the smoke-nuisance and the alleged increase of fog in our cities are creating a degree of excitement rarely awarded in this country to any subject of a practical non-hysterical character. We can only hope that the public feeling will not die out without leading to some definite results, and

that the nation will listen to sound common-sense advice, such as that of our author, rather than to the teachings of sensationalists.

The outline-history of ventilation in this country is not without a melancholy interest. We are introduced to one Sir Jacob Ackworth, whilom Surveyor to the Navy, a man who carried his opposition to improvement and discovery beyond the boundaries of candour and honesty. Dr. Desaguliers had devised a machine for ventilating the holds and 'tween decks of ships, in place of the traditional wind-sails, which were of course useless either in a calm or a storm. Sir Jacob was requested to report on certain experiments at Woolwich. "He began by throwing difficulties in the way, and he avoided witnessing an experiment when the Doctor was present. When he did attend he chose a time when plenty of wind was blowing. He had his favourite wind-sails hoisted, and said to the Doctor's representative—'I would have you work the engine, and see whether that will throw out so much air as our wind-sails do.' The man with astonishment replied that the blowing-wheel was to be used when the sails were useless. But Sir Jacob stuck to his prejudices, and would not stay any longer." He afterwards wrote a report condemnatory of the invention, without having ever seen it.

In 1739 Mr. Sutton, a brewer, hearing of the anti-sanitary condition of the Fleet, devised an ingenious plan of making the fires of the ships' coppers draw their supply of air from the hold, thus keeping up a thorough circulation whenever the coppers were in use. He, too, had to encounter Sir Jacob, who tried every expedient to thwart him. But Mr. Sutton was not to be tired out. An official experiment performed at Deptford, before the Lords of the Admiralty and several members of the Royal Society, succeeded in spite of Sir Jacob. Still, in the end, official obstructiveness and indifference carried the day. The system was not introduced, and two years after the decisive experiment the Lords of the Admiralty offered Mr. Sutton £100 for the trouble and outlay which he had incurred!

It must not be supposed that Sir Jacob Ackworth is dead. We have known him, when commissioned to report on a system of sewage-treatment, carefully select a time of flood when the volume of water was far greater than the tanks could possibly receive. But Sir Jacob gravely took his samples for analysis, and as gravely published the results as a proof of the inefficiency of the process. On the other hand, in case of a method of dealing with sewage which he favoured, we have known him just as carefully select the most favourable weather.

On another occasion, a certain person who is no chemist "wrote to the papers" that metallic salts are incapable of precipitating dissolved impurities from water. Sir Jacob at once printed the rash statement, and when a chemist of European reputation asked, in reply, for the evidence upon which this

assertion was based, his letter was consigned to the waste-paper basket.

Sir Jacob is, in short, an influential, prosperous humbug. He edits journals, political, literary, "society," and even—*proh pudor !*—scientific. He is on the council of our learned societies, and always recommends himself for re-election. He is active in organising exhibitions, and some even say that he is the unseen head of a "department."

Mr. Edwards appears to have come in collision with this evil genius. He, too, has occasionally written to expose some error or absurdity, but Sir Jacob's influence was sufficient to ensure the rejection of his communications.

The author's proposals for the better economy of heat are for the most part highly judicious. He recommends for windows double panes of glass, placed about a quarter of an inch apart, or, for larger rooms, double sashes with an interval of five to six inches. Experience in various countries has abundantly proved that such arrangements materially check the loss of heat in winter. At the same time they involve a loss of light, an article not too abundant in the narrow streets of our smoky cities. And as long as the woodwork of the windows and doors is executed by "contracting" masters and trades'-unionist workmen, so long will it admit plentiful currents of cold air. A more important feature is the proposal to utilise the warm air from the fires in the lower stories of a house, for the benefit of the rooms situate above them. It is generally admitted that from three-fourths to seven-eighths of the heat evolved by combustion of coal, in our open grates, escapes up the chimney. But here it is confined within a stack of masonry of such thickness that its effect upon the temperature of the rooms above is practically null. Mr. Edwards proposes to convey it upwards by means of cast-iron pipes, so that it may give off a large proportion of its heat in the house. We like this proposal; but we doubt whether it is capable of adaptation to houses already built. In another respect we are compelled to differ from him. He thinks it hopeless to induce the English public to take to close stoves. We reply that the experiment has never been fairly made with the earthenware stoves used in various parts of the Continent, which have many advantages over those of iron.

Mr. Edwards criticises certain recent proposals and improvements, so-called, for warming dwelling-houses in a masterly manner. He shows the absurdity of the fire-grates on a level with the floor, which, in utter defiance of scientific principles, have been foisted upon the public within the last half-century. This is the fatal objection to the "Country Parson's Grate," which, in addition, requires a very high class of fuel. It has, however, the advantage, as our author shows, of minimising the quantity of iron placed in contact with the fire. The "Norwich" or "Slow Combustion Stove" has the defect of a solid bottom

the chief point in which it differs from ordinary grates. If the regulator in the chimney is not attended to, and the "blower" used, it consumes a very serious quantity of fuel, and roars like a furnace. The author's own grate for dwelling-rooms is difficult to describe without the aid of diagrams. Like Dr. Arnott's, it is kindled from above. For kitchens he, at any rate, condemns open fires, and recommends that the boiler for supplying hot water, the oven for roasting and baking, &c., should be heated by closed furnaces fed with coke or anthracite. It is, however, the question whether most cooking operations may not be performed with more economy and cleanliness by means of the gas-ovens devised by Mr. Fletcher.

One difficulty remains: in thousands of houses the open fire in the kitchen has to serve the purpose, in all times of wet weather, of drying linen on "washing-day." This duty, we fear, cannot be well fulfilled either by the gas-oven or by a closed stove.

We fear, however, that the difficulties in the way of any thorough improvement in the warming and ventilation of our houses, and indeed of all matters connected with domestic sanitation, are rather of a sociological than an engineering nature. Nevertheless Mr. Edwards has done a good service in bringing so many neglected truths before the public, and we much regret that in certain quarters he has been encountered with the "conspiracy of silence."

General Physiology of Muscles and Nerves. By Dr. J. ROSENTHAL, Professor of Physiology in the University of Erlangen. London: C. Kegan Paul and Co.

WE have here a summary of what has been done in a special, important, and difficult branch of biology. Everyone knows that an explanation of certain processes in the animal system—such as digestion, respiration, and secretion—necessarily involves an appeal to chemistry. In a very similar manner the functions of the nerves and muscles can be studied only by the physicist. The author, after an introductory chapter, in which he pronounces movement and sensation as animal characteristics, in so far at least that special organs for movement—muscles—have never yet been traced in plants, gives an account of protoplasmic amœboid, and ciliary motion. He then describes the form and structure of muscles, their connection with the bones, their elasticity, irritability, the generation of heat during their action, their alteration in elasticity, exhaustion, and recovery, and the source of the force which they display. This is traced to chemical changes within the muscle itself, and affecting not so much the

albuminoids as the glycogen and inosite. The smooth-fibred muscles, which subserve the involuntary movement of the system, such as peristaltic motion, are next described, with the admission that our knowledge of their nature is as yet very imperfect.

We come now to the nervous system, described as consisting of fibres and cells. It is inferred that excitement in the nerve is due to a change in its molecular condition, and occurs as soon as such a change is effected with sufficient speed.

Dr. Rosenthal then proceeds to examine a class of phenomena common to both muscles and nerves, in contradistinction from other animal organs and from the tissues of plants, *i.e.*, their regular and powerful electric action. In three fishes—the torpedo of the Mediterranean, the electric eel of South America, and the *Malapterurus electricus* of the Bay of Benin—this function of muscular and nervous tissue is intensified by special structural arrangements, so as to form a battery and to serve as an offensive weapon. It appears that every muscle, and part of a muscle, when at rest, is positive on its longitudinal section and negative on its cross section. In a regular muscle-prism the positive tension decreases regularly from the centre of the longitudinal section toward the ends; and the negative tension does the same in the cross sections. During the activity of the muscle the differences in tension decrease. Entire muscles often exhibit but slight differences in tension, or even none at all. Nerves are positive on the longitudinal section, and negative on the cross section. During activity the differences in tension decrease.

The question is discussed whether the muscles are irritable directly, independent of the nerves, or only indirectly, and through the mediation of the nerves. The author considers this point as not decided, but suggests that these two classes of organs, so similar in most other points, may agree in irritability.

Turning from the motor-nerves, we come to three kinds progressively more difficult to understand—the secretory or gland-nerves, the nerves of sensation, and the retardatory nerves. As regards the process by which molecular movements in the nerve-cells can be translated into consciousness, Dr. Rosenthal, with Du Bois-Reymond, admits complete ignorance. The notion of Schopenhauer, who ascribes sensation and consciousness to all molecules, seems to him, as it does to all men of sound mind, but a questionable gain. Nor does he consider the question whether conscious conceptions can arise in the nerve-cells of the spinal cord as fairly open to scientific discussion. He points out the error of supposing that the sense-nerves are specifically different and irritable, each by some definite influence alone. It is not, *e.g.*, the optic nerve, but a special terminal apparatus in the retina, which is sensitive to light.

A common error is next exposed. Our sensation of light bears

no likeness to the physical process of the ether vibrations which give rise to it. These ether vibrations are the one and the same, though, according to their subjective effects, we call them sometimes heat and sometimes light. "The usual classification of physical processes into those of sound, light, heat, &c., is irrational, because in these processes it gives prominence to an accidental circumstance,—that is, to the way in which they affect human beings, who are endowed with various sensations, whilst in others, such as magnetic and electric processes, it is based on quite different marks of classification."

The rate at which excitement is transmitted along the sensory nerves is not only much slower than is popularly supposed,—30 metres per second,—but it varies in different persons, in the different senses, and according as the excitement is or is not expected. These measurements, it is suggested, represent the crude beginnings of an experimental and physiological psychology. To what will they grow?

We must pronounce this work an exceedingly useful compendium. If we have an objection to urge it is that relatively too much space has been given to the muscles and to the motor-nerves, and too little to those mediating sensation.

Experimental Researches on the Temperature of the Head. By J. S. Lombard, M.D. London: H. K. Lewis.

It will be known to many of our readers that Dr. Gray, M. Broca, and MM. Maragliano and Seppilli had come to the conclusion that the left side of the brain has uniformly a higher temperature than the right. Dr. Lombard has carefully re-investigated the question, with negative results. He finds, from a very prolonged and extensive series of observations, the particulars of which are here tabulated, that the rises and falls of absolute temperature, by which the balance of superiority of temperature is shifted from one side to the other, or by which equality is brought about, follow no definite law, but are governed by agencies liable to constant variation. As the absolute temperature rises, the average difference between the two sides seems to diminish, but the exceptions are so numerous that the author lays little weight uoon this generalisation.

In a second treatise, Dr. Lombard, assisted by Dr. F. H. Haynes, examines the effect of voluntary muscular contractions upon the temperature of the head. It appears that Dr. R. W. Amidon has recently sought to prove not merely that voluntary muscular movement causes a marked rise of temperature at the

surface of the head, but that the contraction of different muscles affect the temperatures of different well-defined areas of the integument of the head, each muscle having a special thermic centre in the cortical substance of the brain, the temperature of which centre is increased when the muscle acts in a degree sufficient to produce a change of temperature in a circumscribed area of the overlying integument, appreciable by means of instruments of no great delicacy. Dr. Lombard and Dr. Haynes find, on the contrary, a rise of temperature in fewer than 4 per cent of their experiments, whilst the cases in which a fall took place were more than five times as numerous. It would seem, however, that in many cases muscular movements disturb the temperature of the head, causing either elevation, depression, or irregular fluctuation.

In a third course of researches Dr. Lombard examines the influence of the temperature of the air upon the temperature of the head. He finds that as the average atmospheric temperature declines, that of the head falls also, though in a very much smaller proportion, a decrease of 11·9° C. in the temperature of the air being accompanied by a fall only of 1·6° C. in the temperature of the head.

The Collected Works of James MacCullagh, LL.D., Fellow of Trinity College, and Professor of Natural Philosophy in the University of Dublin. Edited by J. H. Jellett, B.D., and Samuel Haughton, M.D. Dublin : Hodges, Figgis, and Co. London : Longmans and Co.

The memoirs contained in the present volume are chiefly reprinted from the "Proceedings and Transactions of the Royal Irish Academy." The subjects dealt with are Geometry and Physical Optics, treated from a mathematical point of view. Among the principal of these papers are "The Double Refraction of Light in a Crystallised Medium according to the Principles of Fresnel," "The Intensity of Light when the Vibrations are Elliptical," "Conical Refraction," "Recent Investigations concerning the Laws of Reflection and Refraction at the Surface of Crystals," "Laws of Reflexion from Metals," "Laws of the Double Refraction of Quartz," "Laws of Reflexion from Crystallised Surfaces," "Probable Nature of the Light transmitted by the Diamond and by Gold-leaf," &c. These memoirs are all perfectly well known to those engaged in the study of Optics, so that any examination of their merits would seem an impertinence.

As an Appendix we find two papers on Ancient Egyptian

History. In one of these the author fixes the departure of the Israelites from Egypt at B.C. 1322, and identifies the king, who in pursuing them lost his army in the Red Sea, with Ocaras.

The Weather of 1880 *as observed in the Neighbourhood of London* By E. MAWLEY, F.M.S. London: Bemrose and Sons.

WE have here a most useful summary of meteorological observations for the past year. The author is not merely a student of the weather, but a zealous horticulturist, being Honorary Secretary of the National Rose Society, and he consequently regards the peculiar character of the season under what is its most important aspect, viz., its influence upon organic existence. The year itself, though an improvement upon its dismal predecessor, can scarcely be pronounced satisfactory. It began with severe and unseasonable cold, which proved injurious to many trees and shrubs. The two decisive summer months, June and July, were cold, wet, and windy; and although August fortunately displayed a low rainfall, it was dull and cloudy. The amount of atmospheric moisture was remarkable, especially as being unaccompanied with a corresponding downfall. Snow and exceptional cold came on in October, a temperature of 29·3° F. being realised on the 24th. Whilst the mean temperature of the air was 0·1° above the average of the last thirty-nine years, that of the soil 3 feet below the surface was 0·4° below that of the last thirty-three years. The nights in which the minimum temperature on grass fell below freezing-point reached the serious figure of 136. Rain fell on 166 days to a depth of 3·20 inches in excess of the last twenty years; 81 days were entirely sunless, and the average duration of sunshine was only 3 hours 37 minutes daily.

We hope that Mr. Mawley will find his valuable labours duly appreciated, and no less do we trust that he will have a more cheerful account to render of the season now in progress, though it has made but a poor beginning.

A Treatise on Fuel. By ROBERT GALLOWAY, M.R.I.A., F.C.S., &c. London: Trübner and Co.

THE need of a work on Fuel has long been felt by manufacturers, and in order to meet this want Mr. Galloway has put into book-form the subject-matter of a course of lectures delivered by him,

in the Royal College of Science for Ireland, while Professor of Chemistry in that Institution ; the result being the treatise now before us, containing 136 pages, and about a dozen excellently executed woodcuts, drawn to scale, including Dr. Siemens's Regenerative Gas-Furnace.

The chapters dealing with the Technical Examination and Analysis of Fuel, Pyrometers, and the Regenerative Gas-Furnace are those in which we were particularly interested.

There are some points on which we might have expected greater fulness, but as regards clearness of description nothing is to be desired. On the whole we congratulate Mr. Galloway on his undertaking, and can recommend the work as a very useful companion to the technological chemist, as well as to the manufacturer who is interested in the question of the economy of fuel.

ERRATUM.

Page 243, line 13 from bottom, *for* "lumi in germs" *read* "luminiferous ether."

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

DISCORD AMONG EVOLUTIONISTS.

To the Editor of the Journal of Science.

Sir,—Has it ever struck you as an upleasant fact that modern naturalists or evolutionists—for the terms are nearly synonymous —wash far too much dirty linen in public, and, not content with criticising opinions, indulge in needless personal ties? Among the offenders Prof. Haeckel takes a foremost place. Witness his comments on Du Bois-Reymond's "Grenzen der Natur-erkent-niss," to be found in the Preface to the "Evolution of Man"; his notice of Vogt and of Semper, in the same work; his ascription of a "diseased imagination" to A. R. Wallace; his condemnation of Agassiz, as insincere, "gifted with too much genius actually to believe in the truth of the mystic nonsense which he preached." Prof. Haeckel's comments on Herrn Reichert and Goethe are in one sense perhaps justifiable; but it may well be asked whether these writers deserve notice at all?

We have then, on the other side, Prof. Semper's work "Haeckelism in Natural History." Dr. G. H. Schneider's strictures on Prof. Dohrn, of the Naples Aquarium, go, to say the least, beyond the boundaries of courtesy. The attacks of Mr. S. Butler, and even those of Prof. St. George Mivart, upon Mr. Darwin (*see* "Lessons from Nature") seem to me open to the same objection.

If naturalists would bear in mind how greatly their difficult task is impeded by such outbreaks, and what delight these bickerings afford to the enemies of scientific progress, they would, I think, be more mindful of the *suaviter in modo*.—I am, &c.,

B. R. P.

A FIRST CAUSE.

To the Editor of the Journal of Science.

Sir,—Can you, or any or your anti-monistic contributors, produce a reply to the following argument of Dr. Büchner's?—"It is evident that a force can only exist in as far as it is active; but a creative force, the first cause of the world, could therefore exist neither before nor after creation, since both before and after this act it would have to be inactive, and inaction is irreconcilable with force."—I am, &c.,

A Lucretian.

CHEMISTRY AND THE SEXES.

To the Editor of the Journal of Science.

Sir,—I expected to have been able to supplement my paper on the "Materialism of the Sexes" with one on "Life," and to have answered my critic, F. G. H., therein; but pending its preparation I will reply now, lest he mistake silence for consent.

1. How oxygen upsets my analogy I fail to perceive, nor does he explain. The *elements* are dual, but *one* element is not.

2. Because Berzelius recognised that the grouping of the elements was only a *relative* distinction, does that bind the world to eternity to accept Berzelius as an infallible authority?

3. F. G. H. denies that both classes of metallic and non-metallic elements are necessary to the formation of productions, and cites sodium amalgam, adding parenthetically his own contradiction, for he says it is attended with the production of "flame." If F. G. H. will show the world how flame can be produced without the assistance or participation in it of the above dual classes, his fame is made.

4. F. G. H. is facetious because I describe air as a "dual *combination* of oxygen, nitrogen, and *hydrogen*"! What his objection exactly is, is not clear. Whether *three* elements combining—although two are of one class, and one of another—is not a *dual* combination, or whether he denies *hydrogen* to be a constituent of air, no one can gather from his sentence. Perhaps he knows what he means himself, but the object in writing is usually to make others divine the meaning clearly.

5. The critic's last sentence is the strangest of all. Because compounds have properties "totally" different from their ele-

ments, therefore we should not seek in the elements for the properties of a compound such as protoplasm. As the properties are not "totally different," but merely *varied*, the statement shows F. G. H. is ignorant of the properties of the elements; and further, if we are not to examine the elements of protoplasm to discover its properties, we suppose neither are we to examine bricks and mortar to see whether a building is to be erected durably or not.—I am, &c.,

AND. DEWAR.

THE EVOLUTION OF THE CHEMICAL ELEMENTS.

To the Editor of the Journal of Science.

SIR,—It has often been remarked as a curious fact that elements closely allied in their properties are very commonly found together in Nature, as is shown in the case of nickel and cobalt, of sulphur and selenium, and, above all, of the earths in Samarskite. I am not aware, however, that the bearing of this fact upon the question of the origin of the elements has ever been taken into consideration. If the elements have existed as distinct bodies from all eternity, or have been separately created, what is the likelihood, according to the doctrine of chances, that those most similar to each other should occur in close juxtaposition? Surely very small! Nor can it well be contended that they have been brought together by the force of chemical affinity, which acts between the unlike rather than between the like. But if we suppose that the elements have been formed from some original material or materials, we can well expect that bodies differing but little in their nature should be formed under the action of nearly identical circumstances, and should consequently occur together locally, just as is the case with organic forms.—I am, &c.,

ABNORMAL.

DR. R. LEWINS, as the author of the work referred to ("Journal of Science," April, p. 202) by Frank Fernseed, wishes to point out that his meaning has been misapprehended. He does not object to qualified men devoting their time to research so long as their powers admit, and is very far from proposing any restrictions upon Science.

NOTES.

In a paper on the History of the Solar System, communicated to the Royal Astronomical Society by Mr. G. H. Darwin, F.R.S., the author concludes that the orbits of the planets round the sun can hardly have undergone a sensible enlargement from tidal friction since these bodies attained a separate existence. He holds that his investigations show no grounds for the rejection of the nebular hypothesis.

Dr. A. Wilson, F.R.S.E., in a paper read before the Royal Institution, contended that the original condition of organisms is "colonial." The universal segmentation of the egg is a proof of this inference, and the development of new forms by this so-called process, in Gregarinæ, &c., supports this conclusion. The lower we proceed in the scale of being the more marked is the tendency to form "colonial" organisms. Arrest of development, by causing an organism to cease progressing at a segregated stage, will tend to produce a "compound" and "colonial" constitution. The plant world is colonial in its highest types. A tree is in many respects as markedly colonial as a volvox. The highest animals exhibit lingering traces of an originally colonial nature in their histological composition. The tendency of life-development is towards concentration and the conversion of the colony into the individual. It is suggested that the theory and idea of an originally colonial constitution may explain the existence, in man and higher animals, of tribal and family associations. The semi-independent action of many parts of the higher brain receives an explanatory hint as to its cause from the idea of an originally independent and colonial constitution.

Dr. Beale's attack upon Darwinism, delivered on resigning the presidency of the Royal Microscopical Society, will not be printed for distribution as is usual on such occasions.

The said Microscopical Society has become the subject of comment in connection with the Quekett Medal Fund, and the rejection of the offer of a Fellow to found two annual medals, one for improvements in the microscope, and the other for microscopical research.

In the "Archives de Biologie" (Belgian) M. Jules McLeod gives an interesting account of the poison-apparatus of spiders.

According to "Forest and Stream" oysters are sometimes rendered dangerous and various fishes are poisoned by the discharge of poisonous gases from the bed of the sea.

The "American Naturalist" gives an account of *Dysodus pravus*, the Japanese lapdog. Though differing generically from *Canis*, it appears to interbreed freely with the common dog.

M. A. Muntz, in a communication to the Academy of Sciences, shows the presence of minute traces of alcohol in natural waters and in soils rich in organic matter. He concentrates by fractional distillation, converts the alcohol into iodoform, which is then recognised microscopically.

According to the researches of Bonnet ("Biedermann's Central-Blatt") the blood reaches its minimum daily temperature between midnight and 3 a.m. The maximum temperature is observed between 2 and 4 p.m., though in permanently hot weather it may be delayed till 8 p.m. Neither sleep nor wakefulness, hunger nor satiety, neither age nor sex has any influence.

According to the experiments of Mr. F. Hatton, reported in the "Medical Press and Circular," bacteria are capable of living in contact with atmospheres of hydrogen, nitrogen, carbonic oxide, carbonic acid, sulphurous acid, nitrous and nitric oxide. Cyanogen proved fatal at first, but on its decomposition the bacteria revived and multiplied. Salicylic acid, strychnine, morphine, narcotine, and brucine had no perceptible action. Phenol, alcohol, spongy iron, and permanganate are said to have a very destructive effect on bacterial life, though in the next sentence Crace Calvert is said to have previously shown that bacteria can live in strong carbolic acid.

Peace appears to have been restored in Guy's Hospital, and nursedom is henceforth to remain in becoming subordination to the medical staff.

The University of St. Andrews has given in its submission to the Women's Rights agitators.

Mr. A. B. Wynne, F.G.S. ("Geological Magazine") considers extensive glaciation at low levels in the north of India improbable.

In consequence of the number of sheep worried, the Legislature of Missouri have passed no fewer than twenty-two Acts relating to dogs last winter, and about half as many more Bills on the same subject have been introduced in the present Session.

We are happy to learn that a Bill for the suppression of physiological experiments, introduced into the Legislature of New York, has been thrown out.

The "Medical Press and Circular" states that Mr. Dodson, President of the Poor Law Board, has instructed the Oldham Guardians to use their own discretion as regards the prosecution

of parents who have been summoned more than once for refusing to have their children vaccinated.

We learn that C. H. Kehnroth, one of the professors at Dr. Buchanan's College, was sentenced, on February 12th, to one year's imprisonment, for issuing "bogus" diplomas—a very moderate penalty.

According to Prof. James Law, small-pox is exceedingly common among pigeons and poultry in India and Italy.

We regret to find, in the prospectus of the forthcoming Exhibition at the Crystal Palace, "birds of paradise, humming-birds, and other bright-plumaged birds" figuring in Class X., among "raw materials for clothing, ornament, or fabric."

Nies and Winkelmann show that solid tin floats upon melted tin, just as ice does upon water.

Several eminent authorities maintain that spectral lines are atomic spectra, whilst bands are molecular spectra.

L. J. Templin ("Kansas City Review of Science"), after a survey of the history of the vegetable kingdom, maintains that the rule of development that has governed in the introduction of higher forms has been by sudden jumps, and not by gradual modification.

According to the Paris correspondent of "Science" a criminal who had been executed by hanging was completely restored to consciousness by a powerful electric current, but succumbed, on the second day following, to cerebral congestion.

Dr. B. Joy Jeffries has made a careful examination on the prevalence of colour-blindness among the school-children in Boston. He finds this defect in 4·202 per cent of the males, and in only 0·066 per cent of the females—results agreeing substantially with those obtained by the most careful observers in Europe.

Prof. J. M. Long, writing in the "Kansas City Review of Science and Industry," remarks that Evolution claims to be the explanation of proximate causes, laws, and origins, not of ultimate ones. The opponents of Evolution seem utterly unable or unwilling to understand this distinction.

A new insect pest is said to be committing grievous havoc in the olive grounds of the south of France.

Dr. R. S. Ball, F.R.S., in a lecture delivered at the Royal Institution of Great Britain, remarked that the star Groombridge (1830) is either a runaway, or the masses of the bodies in our system must be much greater than it has been assumed.

Prof. Bredichin ("Monthly Notices of the Royal Astronomical

Society") infers that the tails of the three types of comets are composed respectively of iron, hydrogen, and carbon.

The milk of cows takes a reddish colour if they have eaten the leaves of madder or of *Galium verum*.

M. W. Koster ("Archives Neerlandaises des Sciences Exactes et Naturelles) shows that there is no specific difference between the muscles of the hand in man and in the anthropoids. (See, also, "Verslagen en Mededeelingen d. K. Akad. v. Wet.," 2 Ser., t. XIV.)

Certain human bones, found imbedded in an undisturbed clay at Nice, apparently belonging to the quaternary epoch, are ascribed by M. de Quatrefages to the Cro-Magnon race.

According to "Les Mondes" the photophone is applicable to the study of the Aurora Borealis.

During the past year 422 students have received instruction in Applied Physics and Applied Chemistry at the Cowper Street Schools, in connection with the City and Guilds of London Institute. The income of the Institute for the year 1881 will be not less than £18,515.

According to Von Nägeli and O. Loew the lower Fungi can derive nourishment from alcohol, phenol, salicylic and benzoic acids.

Among the recently observed noxious insects must be reckoned *Gelechia cereabella*, a moth belonging to the Noctuidæ, which in its larva stage injures barley; and a Hemipterous insect, *Lygæus leucopterus*, which has committed enormous ravages in the wheat district to the south of Lake Erie.

A paper on the "Increasing Number of Deaths from Explosions, with an Examination of the Causes," was read before the Society of Arts, March 23rd, by Mr. C. Walford, F.I.A., F.S.S., Barrister-at-Law. The learned author directed attention merely to boiler and coal-mine explosions, but the general feeling was that the public is not sufficiently protected.

M. Toussaint, of the Veterinary School of Toulouse, has devised a method of protecting sheep against splenic fever by means of preventive inoculation.

According to M. S. P. Langley ("Comptes Rendus") the maximum of solar energy, prior to the absorptive effect of the atmosphere, is found nearer the violet than the ultra-red. The totality of the solar radiations would give a sensation of blueness rather than of whiteness.

M. E. Mercadier, in the same journal, shows that the radiophonic sounds produced with the selenium-receiver are due to luminous radiations.

M. Crova, in a paper read before the Academy of Sciences, shows that elevated temperatures can be measured by means of the spectro-pyrometer—a modification of the spectroscope.

Valdivine and cedrine, principles extracted from the so-called cedron-nuts, are utterly useless as a remedy for the bites of serpents and for hydrophobia.

According to M. J. Chatin ("Comptes Rendus") trichinæ may occur, in the encysted state, in the fatty tissues of animals, as well as in their muscles.

MM. J. Béchamp and E. Baltus, in a communication to the Academy of Sciences, prove that recent pancreatic microzymas injected into the blood of an animal occasion rapid death as soon as their proportion reaches 0·0001 gramme per kilo. of its entire weight.

M. Letourneau laid before the Société d'Anthropologie, of Paris, some details concerning the sailor Pelletier. He had been shipwrecked when twelve years of age on the coast of Australia, and had become completely assimilated to the savages among whom he had lived. When questioned by the French Consul at Sydney, he wrote the name of his native place and that of his ship in one word. He tried to write to his father, but what he wrote had no meaning. In a few days he recollected some fifteen to twenty French words.

From the reply of Mr. Gladstone to a society for the prevention of "cruelty to animals," there is just reason to fear that further restrictions will be put upon physiological research, the Liberals completing the evil work which the Conservatives began. "A plague on both your houses!"

We regret to learn the death of Mr. E. R. Alston, Secretary of the Linnean Society, and one of the contributors to the "Biologio Centrali-Americana."

Science has sustained another loss in the decease of Mr. F. A. Nobert, well known for his delicate micrometers and test-plates.

The "Medical Press and Circular" records the fate of a country woman who made cheese-cakes of arsenic, mistaking it for pounded rice!

The "Revue Internationale des Sciences Biologiques" criticises M. Pasteur very severely, noting especially the aureola seen under the microscope, apparently surrounding certain bacteria.

From the same journal we learn that M. Bouley, for whom a chair of comparative pathology has been just created at the Museum of Natural History, seems more pre-occupied with financial questions than with scientific research.

Dr. M. C. Cooke, in calling the attention of the Quekett Club to some Desmids new to Britain, gives an account of the best method of preserving them permanently for microscopical observation. The most important object to be secured in mounting Desmids is rather the preservation of the empty frond, as for scientific purposes this is often of superior value to one filled with endochrome, as it permits the *punctæ* or markings of the segments to be seen, which are obliterated whilst the endochrome remains. For the study of the endochrome alone of course its presence is most important; but this can be done, and drawings made from the plant in the living state, and if specimens can be mounted with the endochrome unchanged and uncontrasted so much the better. One great difficulty in mounting objects with such thin and delicate cell-walls as Desmids is to employ a medium of no greater density than the cell contents. If a denser medium, such as glycerin, be used, the endochrome immediately contracts, and never expands again as before. Water, or water containing a little camphor, is of equal density, and no change can be detected. After all, the preservation of the endochrome is of less importance than the perfect contour of the cell. If there is any contraction or collapse the objects are useless. Supposing, therefore, that there is no necessity to preserve the endochrome, there is another feature to remember besides the preservation of contour, and that is, that the medium employed should not render the delicate cell-walls so transparent as to become ultimately invisible. In simple water Dr. Cooke found no difficulty in discerning the structure of the cell-walls after a period of not less than twelve years. So much cannot be said for glycerin. As a hint it may be added that empty fronds, both of Desmids and Volvox, stained of various colours, exhibit all the details in an unexceptionable manner.

Some time ago we ventured to predict that not even the total suppression of vivisection would satisfy the hysterical party. Our words are being fulfilled. It is voted cruelty to feed snakes with live rabbits, &c., and as they will not, as a rule, touch dead food, English naturalists will have to go abroad if they wish to study serpent life.

Lest the chemists should laugh at the biologists, it is proposed that the three chief mineral acids—the sulphuric, nitric, and hydrochloric – should be placed on the list of poisons, and their sale encumbered with red-tape precautions. This idea, if carried out, will no doubt wonderfully facilitate chemical research in England.

M. Pasteur has received the gold medal of the French Society of Agriculturists for his researches on fermentation and contagion.

The "Scottish Naturalist" for April contains the first portion

of a carefully written biography of George Don, of Forfar, the eminent botanist.

"Science" brings forward proposals for a revision of anatomical nomenclature, referring to "the care bestowed upon the language of modern chemistry." We devoutly hope biologists will never take the language of chemistry as their model.

The same journal gives a communication from Col. W. A. Ross, which, unless some occult error or oversight interfere, points the way to a modification of our views on the chemistry of anhydrous compounds.

We learn that Dr. Buchanan, the dealer in spurious diplomas, is now an inmate of the Eastern Penitentiary, Philadelphia.

The Faraday Lecture was delivered by Prof. Helmholtz on the 5th ult. The lecturer's subject was "The Modern Development of Faraday's Conceptions of Electricity."

M. J. Delaunay ascribes earthquakes to the passage of the larger planets through the cosmic groups of meteors. He predicts violent earthquakes for the years 1883, 1886, 1890-91, 1898, 1900-1, 1912-13, 1914, 1919-20.

According to Prof. Morselli, of Milan, suicide has increased in England at the rate of 57·7 per cent since 1836; in Prussia, at the rate of 32·2 per cent since 1816.

M. Charles Dufour, in a paper read before the French Association for the Advancement of Science, shows that the glaciers of the Alps, the Pyrenees, and the Caucasus are all receding.

The drainage of certain parts of Epping Forest, near Chingford Station, will probably lead to the extirpation of many forms both of animal and vegetable life. A similar catastrophe, on a far larger scale, will result from the projected drainage of the Everglades of Florida, a district whose flora and fauna are but very imperfectly known.

Prof. Du Bois-Reymond is about to publish the researches of the late Karl Sachs on the electric eel (*Gymnotus electricus*) of South America.

Dr. Delaunay takes as a test of intelligence the direction in which a person draws a circle or executes a rotatory movement. Those whose minds are more highly developed move the hand from left to right, as in the daily movement of the sun, whilst the dull and stupid take the opposite direction.

Nineteenth Year of Publication.

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THE

JOURNAL OF SCIENCE.

JUNE, 1881.

I. HYLOZOIC MATERIALISM.

Communicated by ROBERT LEWINS, M.D.

"Audi alteram partem."

THE two chief opponents by whom the Materialist is encountered are the negatively Agnostic *savant** and the Christian divine; yet his theorem is simply a logical deduction from the fundamental principles of Science and Theology. Of Science, which cannot logically assume two causes where one is sufficient, and must therefore deny that matter, being essentially active, needs to be "inspired" by a vital [or motor] principle; of Theology, which, by postulating the existence of one Infinite *Omnipresent* Deity, in whom we "live and move and have our being," destroys, at the very outset, all distinction between body and soul, between God and the world. This last result of insight and reason is also the first dictate of instinct and nature, for every child, every savage, every simple and healthy human being is an unconscious Materialist. Yet although this Hylozoistic thesis is at once the expression of primitive feeling, the legitimate product of modern Physics, and the scientific equivalent of ancient Pantheism, it has been met, by learned and ignorant alike, with greater antagonism and anti-sympathy than have been accorded to any other theory

* Of living *savans*—not to mention the great shades of Newton, Sir John Herschell, Brewster, and Faraday—who are supporters of Animism, may be mentioned the distinguished names of the Astronomer-Royal, Sir George Airey, the Lucasian Professor Stokes, Professor Adams, the discoverer of the planet Neptune, Mr. St. George Mivart, Professor Lionel Beale, Mr. Crookes, Mr. Wallace, &c.

of the universe. Though it is exemplified in their practical conduct, and implicitly recognised in their habits of thought and sentiment, they shrink with repugnance from its verbal exposition. Lately, however, it has forced itself upon public attention, and become an object of more calm and respectful criticism; and I here propose briefly to examine the principal objections with which it now has to deal, and to endeavour to estimate their force. They resolve themselves into these:—1st. That as man can know nothing beyond phenomena, he cannot absolutely deny the existence of an immaterial principle, or soul, animating the material body. And 2nd. That matter is, in its essence, inert, and therefore incapable of sensation and thought.

A little reflection will show that these two positions are mutually destructive, as the latter, which is purely metaphysical, claims for man not only a *positive*, but a *negative* knowledge of noumena. Though he cannot predict how Nature *will* behave under every possible combination of circumstances, he is yet capable of deciding how she will *not* behave. Except from his own sensations, he can learn nothing of the potencies of matter, yet he feels justified in assigning them a certain boundary, and declaring that they shall go thus far and no farther.

It is evident that we can obtain nothing from an idea which we have chosen to exclude from it; and if we arbitrarily limit the attributes of matter to extension and impenetrability, there will be a large class of phenomena which lie without the sphere of our science, and appear to be of supernatural or spiritual origin. But we are assured by the Law of Gravitation, as formulated by Newton and Laplace, that *energy* is as inseparable from every particle of matter as impenetrability itself; and this single addition to our idea supplies the place of all former animistic theories. The force which sustains and guides the orbs of heaven is not a distinct or external entity, but is immanent in every atom of their mass; and this "generalisation from the Newtonian discovery cannot be restricted to 'brute' matter; it is equally applicable to the organic kingdom of Nature, to plants, animals, and man. . . . The question of the *anima mundi* and *anima humana* (using the term in the sense of soul) is at bottom one and the same." *

In Mr. Barker's first article on "Life and its Basis," in the January number of the "Journal of Science," he justly

* Life and Mind on the Basis of Modern Medicine, by R. LEWINS, M.D., reviewed in the "Journal of Science" of November last.

remarks that "the belief that matter is, *per se*, *passive*, carries with it the belief in creative acts." It is not less true that the certainty that matter is, *per se*, *active*, renders all such beliefs—including the hypothesis of a distinct, immaterial, vivifying agency—both superfluous and absurd. Dualistic philosophy is deprived of its *raison d'être* by the removal of the sharp distinction between death and life, and by the theorem that both are diverse manifestations of one and the same energy. And this furnishes a reply to one of the objections mentioned at the beginning of this article, that, namely, which derives its force from the supposed impossibility of proving a negative. Total want of evidence is equivalent to *disproof*, and is practically so considered.

If we cannot deny the existence of the "soul," neither can we deny that of fairies, goblins, ghosts, or of the genii or "ruling angels," * which were anciently believed to inhabit the planets and regulate their orbits. Yet it would scarcely be considered a wise exercise of scientific scepticism to suspend our judgment upon the truth of the "Arabian Nights." Nay, more; there is an immense mass of legal and other evidence in favour of the reality of witchcraft; but since we see that all its supposed effects may be produced by natural causes in the province of Nosology, and since the supernatural explanation is out of harmony with our present habits of thought, we contemptuously dismiss a doctrine held by many generations of intelligent men, and never, except inferentially, disproved. We may, in the same manner, dismiss from serious consideration that invisible, intangible, indemonstrable entity, whose supposed function as an animating principle is fully discharged by the *vis insita* of matter alone. The innate force which sustains the mechanism of the universe is surely sufficient to produce all the phenomena of animal and vegetable life, more complicated, but not more mysterious, than the motion of the earth round the sun, or the falling of a stone to the ground. But it may be urged that, even taking into account this inherent energy, it is impossible to explain the powers of properties of organic by those of inorganic bodies. It may be said that mental and moral faculties "are not qualities of *matter*, not even of *living* matter, or they would be exhibited by plants and trees as well as animals." This is certainly true. There is nothing in a lump of earth, or even in a blade of grass, which can lead us to suppose that its

* *See* Pope's line in his "Essay on Man":—

"Let ruling angels from their spheres be hurl'd."

constituent atoms will ever become part of a sentient organism. But no argument can be drawn from this truism, unless we assume that the most easily ascertainable properties of any substance enable us to predict its behaviour under all possible conditions. If this were so, the laws of one science would afford the complete *rationale* of every other, and we might have discovered the electric telegraph by means of the Law of Gravitation, and the composition of water by the principles of Hydrostatics. But even directly related phenomena flatly contradict such an assumption. The cause refuses to account for the effect,—the effect to reveal the cause. This truth cannot be more strikingly illustrated than by the modern science of Chemistry. From the individual properties of any two elements we can neither infer *à priori* nor explain *à posteriori* the result of their union. In following the history of any chemical compound, we meet with phenomena not less wondrous and inexplicable than those of Life and Consciousness. I select a well-known example:—Nitrogen and carbon, two inodorous and innoxious elements, unite to generate cyanogen, an extremely poisonous gas, emitting a peculiar and penetrating odour, and producing, in combination with oxygen, six isomeric compounds. One of them, cyanic acid, is a clear and strongly odorous liquid, which cauterises the skin like red-hot iron, but in a few hours spontaneously solidifies into cyamelide, an opaque white solid, inodorous, and without acid qualities. Here it is evident that the constituent atoms no more possess the qualities of the compound than the molecules of the brain are individually endowed with the powers of judgment and reflection. Yet we do not find it necessary to assume the addition of a poisonous and odorous immaterial principle to the compound cyanogen, nor the exit of such an entity from cyanic acid, when it is transformed into its isomer.

The science of Chemistry may, indeed, fittingly illustrate that of Biology, for the vital act itself is a purely chemical process. The life of man is identical with the life of a flame, being maintained by the oxidation, or slow combustion (eremacausis), of organic tissue, at a temperature of 98° F. The oxygen, which but a moment before formed part of the apparently non-vital atmosphere, imparts vitality to the human frame, with which it is for a time incorporated. Being absorbed by the blood in its passage through the lungs, it is conveyed by heart and arteries to the network of infinitesimal capillaries, and from these to every atom of the living body, where it at once integrates and disintegrates, constructs

and destroys. Life waxes or wanes as this non-incandescent fire burns with more or less activity, and ceases with its extinction. Its feebleness in old age causes a corresponding decline in keenness of sense and intellect, and in strength of character; for chemical conditions exercise the same control over moral and mental powers as over those which we have been accustomed to distinguish as purely physical. The function is uniform, the product diverse; for secretion, in all its forms, muscular motion and consciousness are but different results of the same invisible antecedent process, which alone sustains and vivifies "body, soul, and mind." Thus the "cellular vitality" is really identical with that of the conscious brain, and the living corpuscle perfectly typifies the living organism, of which it is a microscopic constituent. The relation is that of Microcosm and Macrocosm. This fact disposes at once of the distinction between that "corpuscular life" which is common to animals and plants, and the "anima" which a consistent dualist must believe to reside in the lowest form of organised matter capable of sensation and volition.* The first dawn of consciousness is not more easy of explanation than the subtlest processes of human thought, and both must evidently be traced to the same origin, viz., to the inherent energy of matter, manifesting itself in more or less complex organisms. To regard sensation as proceeding from a super-material essence—a *donum divinum* superadded to organisation—rather than from that physical development of nerve tissue with which it is invariably associated, is to prefer hypothesis to thesis, fable to fact.

It must be difficult, even for the most ardent dualist, to believe that, although the mental and moral faculties may appear to be irretrievably impaired by a serious injury to the cerebral hemisphere, the soul yet remains intact, and will be restored to more than pristine vigour by the final destruction of that corporeal mechanism whose *partial* disintegration has already paralysed will, emotion, and thought.

* The so-called process of "assimilation" carried out by plants is, of course, the direct reverse of animal respiration; yet in both cases vitality is sustained by a chemical process; and it must not be forgotten that vegetables also respire, and that, although they absorb oxygen in relatively small quantities, it is not less necessary to their life than to that of animals. Perhaps I may be excused for referring here to a statement in Mr. Barker's article, which I cannot but suppose must have been inserted by some inadvertence. He asserts that, while animal forms of protoplasm comprise all four of the elements,—carbon, hydrogen, oxygen, and nitrogen,—"vegetables, with a few exceptions, contain only the first three." It is a fact well known, not only to the botanical chemist, but to the practical agriculturist, that vegetable protoplasm *invariably* contains nitrogen, and that crops will not thrive if the soil be deficient in nitrogenous substances.

Every medical practitioner acts on the material theory of mind, just as every Evolutionist implicitly asserts it. The Darwinian and any other modern theory of Evolution *must* be essentially materialistic, since the continuity of the chain of life, from yeast-cell to man, leaves no point where we can assume the intervention of a spiritual entity, modifying or "inspiring" the physical organisms. That the bee has a soul denied to the flower on which it feeds, that man has a spirit to which his dog can lay no claim, cannot logically enter into the "scientific imagination" of our age.

I must here venture to protest against Mr. Barker's assumption that the "initiation of the living state in the lifeless, whether it has formerly been alive or not, must be due to the action of an unseen higher power." As at present observable, such initiation is a process controlled or regulated by ordinary material conditions, though these are too complex to be formulated into definite laws. In what manner the "*vis insita*" of matter may have manifested itself under palæontological conditions it is impossible to determine. It is likewise impossible to affirm or deny the existence of a Supreme Intelligence or Pantheos; but such a conception is plainly inconsistent with Dualism, and can only be founded on the sublime Hylozoistic conception of the Universe. Man has created God in his own image; but he cannot conceive his Deity to be all in all, and truly omnipresent, until he has recognised the sentient and non-sentient Cosmos as an indivisible and homogeneous unity.

C. N.

II. THE BORDER-LAND OF CHEMISTRY AND BIOLOGY.

IT has become an almost trite saying that just as important minerals are most readily discovered along the meeting-line of different geological formations, and as animal species are most numerous along the edge of the forest or of the river, so the most interesting results are often obtained along what may be called the boundary of two sciences. Of this truth a striking instance is afforded by the researches of Dr. James Blake. This experimentalist has for forty years been engaged with the study of a class of

phenomena having both a chemical and a biological aspect, and he has obtained results of great value alike to organic and inorganic science. As far back as 1839 he showed, in a paper read before the Academy of Sciences in Paris, that the physiological action of solutions of different salts injected into the blood of living animals depended mainly upon the electro-positive or basic element of each salt, and were little modified by the electro-negative element or acid. Thus, to take a simple instance, the effects of sodium sulphate differ less from those of sodium nitrate than they do from those of magnesium sulphate.

Again, in a memoir communicated to the Royal Society, in June, 1841, Dr. Blake proved that the action of inorganic substances conveyed directly into the blood of living animals depended on their isomorphous relations,—those bodies which can replace each other in a crystalline compound without disturbing its form having similar physiological action.

A third step was taken in a discourse delivered before the California Academy of Sciences in 1873, the author showing that among metallic bodies the physiological activity of those belonging to one and the same isomorphous group is proportionate to the atomic weights; the higher the atomic weight the more intense is the physiological action.

Finally, in a paper communicated to the German Chemical Society, on February 7th of the present year, Dr. Blake sums up the whole of his results. The first point to be noticed is that the effects obtained were the same in all the species operated upon—horses, dogs, cats, rabbits, geese, and hens. It might, indeed, have been wished that some ruminant animal and some species of monkey had been inserted in the list. The hedgehog, also, in virtue of his alleged immunity from the action of poisons, would have been a desirable subject. Some cold-blooded animal, such as that "martyr of science" the frog, should have been included. These omissions are the more to be regretted since any extension or verification of Dr. Blake's researches is now rendered practically impossible. So far, however, as experiment has gone, we may conclude that the indifference of certain animals to the action of various poisons when introduced into the stomach is due mainly to non-absorption.*

The substances employed were salts of forty-one of the

* This view can scarcely be admitted in case of the remarkable toleration of the salts of morphine in certain apes. That it really enters the circulation is proved by its subsequent appearance in their urine.—Ed. J. S.

chemical elements. They were dissolved in water, and injected into a vein or artery in known quantities. The fatal doses for each individual were carefully noted, and a kymograph was connected with the femoral artery. The curves described by this instrument were strikingly characteristic for some of the isomorphous groups.

Among the monatomic metals tried were lithium, sodium, rubidium, thallium, and silver. All agreed exactly in the mode of their physiological action, but the fatal dose for rabbits, which was 1 grm. per kilo. of the weight of the animal for lithium sulphate, fell to 0·06 grm. for silver nitrate. In other words, lithium sulphate, to kill, must be introduced in the proportion of 1 part per thousand of the living weight, whilst of silver nitrate 6 parts per 100,000 suffice.

Among the group of the diatomic metals Dr. Blake experimented with the salts of magnesium, iron, manganese, cobalt, nickel, copper, zinc, and cadmium. Here, again, the physiological action is similar, the fatal dose being 0·97 grm. per kilo. for magnesium sulphate, and only 0·08 grm. per kilo. for cadmium sulphate.

The salts of calcium, strontium, and barium agree also in their physiological action, which is intensified from 0·47 grm. per kilo. in calcium chloride to 0·043 grm. in barium chloride. The salts of this group produce contractions of the voluntary muscles, even thirty to forty minutes after the action of the heart has ceased. The reactions of lead salts resemble exactly those of the barium group, but at the same time they agree in some respects with those of the salts of silver.

Among the tetratomic metals the author examined those of thorium, palladium, platinum, osmium, and gold. All have very intense physiological action, ranging from 0·029 grm. per kilo. in thorium sulphate to 0·003 grm. for gold chloride. The characteristic of this group is their effect on the action of the heart. Salts of gold introduced into the blood, even in the minute proportion of 0·003 or 0·004 grm. per kilo., keep up the action of the heart for several hours after death, though the body may have cooled down as far as 55° F. below its normal temperature. We may here ask if this is not the explanation of the action of platinum chloride in prolonging the life of animals bitten by the cobra?

Among the hexatomic metals the salts of glucinum, aluminium, and iron (ferricum) were found to agree in their physiological action, the death-dose being 0·023 grm. per

kilo. in the first, 0·007 in the second, and 0·004 for iron, all in the form of sulphates.

Here we are, in the first place, struck with the difference between iron in its two classes of salts, the ferrous and the ferric. Of the former the fatal quantity is 0·115 grm. per kilo., or twenty-eight times as much of the latter.

We next perceive that the distinction between poisonous and non-poisonous substances is reduced to a mere question of proportion. The dogma that "whatsoever is poisonous in large doses is poisonous also in the smallest, though the injury done may escape notice," falls at once to the ground if we reflect that the very salts which naturally occur in and form necessary parts of our blood become deadly in a somewhat larger quantity!

Among the non-metallic bodies the compounds of chlorine, bromine, and iodine were found accordant in their physiological reactions, but the increase of intensity accompanying the atomic weight was not observed—a most puzzling exception. The identity of action here noted is also peculiar, since bromides taken internally have a very different action from the corresponding chlorides, *e.g.*, in the treatment of sea-sickness. Phosphorus, arsenic, and antimony occasion no immediately perceptible physiological reaction, though if arsenious acid is injected in the proportion of 0·56 grm. per kilo. it arrests the pulmonary circulation. Sulphur and selenium agree in their physiological action; the latter, having the higher atomic weight, is the more powerful.

A curious exception to the rule that isomorphous substances agree in their physiological action is afforded by the salts of potassium and ammonium. The effects of the latter approach those of certain nitrogenous alkaloids.

The author suggests that if—as is far from impossible—the carbon-compounds present similar phenomena in their influence upon animal life, a new key to the molecular relations of organic bodies is placed in the hands of the chemist. It is especially to be remembered that in alcohols of one and the same series the intensity of the physiological action rises with the atomic weight, as has been shown by Dujardin. The question in what manner the isomorphous relations and the atomic weights of substances can influence their physiological action can scarcely as yet be entertained.

Still Dr. Blake's researches are exceedingly valuable, both as pointing out a new method of chemical research and as overturning certain erroneous conceptions concerning the nature of poisons.

existing surface of hill and valley; such movement being "unconnected with 'causes now in action,' and in fact independent of them." He thinks that "the mountain masses of the globe, the basins of lakes, the channels of rivers, the deep bed of the ocean, its narrow straits and wide gulfs, are the result of overthrow, rather than upheaval, of fissures and cracks in Earth's surface caused by its contraction and shrinkage while the rocks were in the act of cooling down from the state of a molten mass, like a lava stream, solid above, yet resting on masses still pliant from heat, and movable below." The leading outline of this theory of a primeval split-up of the crust of the globe does not, says "Verifier," originate with him, many geologists—chiefly of the foreign schools—having approximated to it. It will be observed that, in speaking of volcanic phenomena, he uses a simile which is strictly applicable to a living or growing body; they are, he says, to the Earth what boils and pustules are to the human body. I find other writers indulging in language similarly suggestive of the truth of my view of creation. The idea that the Earth's loss of heat from radiation has performed an important part in the changes which have taken place on its surface has been, and still continues to be, a favourite one with a certain class of both astronomers and geologists. It is, however, discountenanced by Sir Charles Lyell in his "Principles." "When we consider," he says, "the discoveries recently made of the convertibility of one kind of force into another, and how light, heat, magnetism, electricity, and chemical affinity are intimately connected, we may well hesitate before we accept this theory of the constant diminution from age to age of a great source of dynamical and vital power." In reply to an "eminent physicist," who ridicules the search for some renovating power by which the amount of heat may be made to continue unimpaired for millions of years, as like the dreams of one who hopes to discover a source of perpetual motion, he answers—"But why should we despair of detecting proofs of such a regenerating and self-sustaining power in the works of a Divine Artificer? What is the origin of the force which governs the motions of the heavenly bodies? It has been likened to the intellectual power of the human will, which initiates and directs all our muscular actions. To define its nature has hitherto baffled the efforts of the metaphysician and natural philosopher, but assuredly we are not yet so far advanced in our knowledge of the system of the universe as to entitle us to declare that a great dynamical force like that of heat is on the wane."—Vol. i., p. 213, 10th ed.)

In suggesting that basins of lakes, channels of rivers, the deep bed of the ocean, &c., have been the result of contraction and shrinkage, while the rocks were "in the act of cooling down from the state of a molten mass," "Verifier" seems to overlook the fact that the character of the strata supposed to be thus affected entirely ignores the possibility of such a conclusion. Whatever may have been the condition of heat under which masses of granite have been produced, deposits of limestone, coal, and other analogous rocks, cannot have been formed when the globe was in the molten condition suggested. When limestone was deposited on the bed of the ocean, and coal was being formed by long successions of vegetable growth on dry land, the surface of the Earth cannot have differed essentially from its present condition. Such a degree of heat as that suggested would have converted the waters of the ocean into steam, and burnt up the vegetation of the dry land. Certainly the valleys and gorges at present existing cannot have been formed when the Earth was so hot that, as suggested by "Verifier," some of the "upper strata," like the waves in a moving lava stream, "would topple over and be absorbed in the glowing abyss below, to be re-melted into granite or trap." I could take him to a wide valley the sides of which consist, besides other stratified rocks, of several corresponding seams of coal lying at different elevations above the bed of the river. The banks slope up gently, the lower seam on each side being separated to the extent of about a quarter of a mile, while the seams above are divided to a much greater extent. Supposing that mere shrinkage from the radiation of heat could have produced such a degree of separation, which is very unlikely, the seams of coal must have experienced such a degree of heat at the time as would have burnt them up entirely and destroyed the present character of the other strata.

"Verifier" questions the assertion of geologists that considerable portions of the dry land are rising at the present time as the result of "tranquil movements of elevation and depression." He argues that, "while the fact itself is doubtful, Geology can furnish no reason why it should occur, which is a strong *prima facie* argument against it." He says that no light is thrown on the time or mode by which beds of sea-shells of existing species have been deposited at various heights considerably above the Baltic, and "we cannot suppose that Wales is at present emerging from the sea merely from the discovery of sea-shells on Moel Trivaen, which may have been placed there before the creation of man. The question we have to deal with is confined to

matter, out of which species and all other things are said to be formed. As a sceptic, he is indeed in many directions unanswerable; but fails greatly when, relinquishing his assumed character, he sets up as a teacher.

Whilst admitting that the *modus operandi* by which the forces now operating are producing geological changes the same in kind and degree as those in the remotest times is not satisfactorily explained by Sir Charles Lyell, I nevertheless believe that the several processes propounded by him have—subject to some correction—performed a part in producing existing results. "The Unity of Nature," so ably elucidated in the "Contemporary Review," by the Duke of Argyll, is so complete that whatever affects a part must exercise an influence—though not necessarily apparent to our senses—upon every other part; and hence it is often difficult to determine what may be logically described as secondary causes, and what may be more correctly recognised as primary. In my book on "The Constitution of the Earth" I have propounded certain laws which are observable in all the changes of Nature, and which, in connection with known phenomena, lead to the conclusion that the Earth has been derived from the Sun by a progressive development still in operation; a conclusion entirely consistent with the formula of Lyell, that "the forces now operating upon the Earth are the same in kind and degree as those which, in the remotest times, produced geological changes." I believe, however, that the Earth is a growing body, and that such vitality as the term expresses may be properly described as the primary cause of the several secondary processes which have issued in its existing biological and geological condition.

"Verifier" objects to the theory which attributes to earthquakes a large share in the conformation of the globe, and points to remarkable cases from which, he says, "it would appear that although parts of the Earth's surface may be raised by the jar of an earthquake, like the lifting of the lid of a box, the truth, as it emerges, proves that this rise is only temporary, and the ground subsides again gradually into place when the shocks are over." I have referred to such phenomena as "the more demonstrative evidences of that vital action which is continually, though with great slowness, adding to the bulk of the Earth."

"Verifier" truly says that "The difficulties of modern Geology are greatly increased owing to its undertaking to produce vast effects with means which, on investigation, appear utterly inadequate to perform them. . . . To

overcome the resistance of a mountain mass, to lift the Alps or Andes, and at the same time to break them up into gorges and valleys, was assuredly due to no modified violence, no gentle taps renewed from time to time. In order to fully understand the magnitude of the work to be done by these gentle jogs, let us transport ourselves for a time into the midst of some of the grandest scenes of Nature's operations. Listen to the evidence of an unbiassed geological observer, possessing a minute knowledge of the highest mountain-chain, the Himalayas. 'The whole mass,' says Mr. Blandford, in a Report attached to the Geological Survey of India (p. 68), 'has been broken and disturbed, the rocks on one side of the fracture having been lifted up many thousands of feet, and crushed and crumpled together as the leaves of a book might be if placed edgeways between the boards of a powerful press. If we continue the section through the whole chain of the Himalaya, for some hundred miles, and still further into Thibet and the plain of the great Gobi, we should still find the same evidence of crushing and contortion. Here, then, is the work of a power compared to which the greatest of earthquakes sinks into insignificance. Since man began to record his experience of natural catastrophes no one has ever witnessed such gigantic movements of the crust of the Earth as here stand in existence.'"

"Verifier" observes that the advocates of modern causes account for the formation of mountains by some upheaving force acting from below, which idea underlies all their speculations. "Lyell," he says, "refers the elevation of mountain-chains to the effects of subterranean power, similar to that which causes volcanic eruptions; yet no one has satisfactorily ascertained the seat or origin of a power which, like that of the fabled giant of old, is to rise up under its mountain burthen. . . . Volcanoes are a purely collateral phenomena, which have existed in all ages of our planet. They are to it what boils and pustules are to the human body, a sort of safety-valve. Through holes in the Earth's crust they throw up cinder and lava heaps, veins, and dykes, after the manner of huge furnace chimneys, ejecting molten matter at their mouths or sides, which sometimes rises into permanent mountains and islands, but seldom effecting movement in the strata adjoining. In nine cases out of ten the outburst of trap and basalt has not raised the adjacent strata."

In opposition to Lyell, "Verifier" suggests that a *lateral* in place of a *vertical* movement has been the cause of the great natural operations which have given our Earth its

existing surface of hill and valley; such movement being "unconnected with 'causes now in action,' and in fact independent of them." He thinks that "the mountain masses of the globe, the basins of lakes, the channels of rivers, the deep bed of the ocean, its narrow straits and wide gulfs, are the result of overthrow, rather than upheaval, of fissures and cracks in Earth's surface caused by its contraction and shrinkage while the rocks were in the act of cooling down from the state of a molten mass, like a lava stream, solid above, yet resting on masses still pliant from heat, and movable below." The leading outline of this theory of a primeval split-up of the crust of the globe does not, says "Verifier," originate with him, many geologists—chiefly of the foreign schools—having approximated to it. It will be observed that, in speaking of volcanic phenomena, he uses a simile which is strictly applicable to a living or growing body; they are, he says, to the Earth what boils and pustules are to the human body. I find other writers indulging in language similarly suggestive of the truth of my view of creation. The idea that the Earth's loss of heat from radiation has performed an important part in the changes which have taken place on its surface has been, and still continues to be, a favourite one with a certain class of both astronomers and geologists. It is, however, discountenanced by Sir Charles Lyell in his "Principles." "When we consider," he says, "the discoveries recently made of the convertibility of one kind of force into another, and how light, heat, magnetism, electricity, and chemical affinity are intimately connected, we may well hesitate before we accept this theory of the constant diminution from age to age of a great source of dynamical and vital power." In reply to an "eminent physicist," who ridicules the search for some renovating power by which the amount of heat may be made to continue unimpaired for millions of years, as like the dreams of one who hopes to discover a source of perpetual motion, he answers—"But why should we despair of detecting proofs of such a regenerating and self-sustaining power in the works of a Divine Artificer? What is the origin of the force which governs the motions of the heavenly bodies? It has been likened to the intellectual power of the human will, which initiates and directs all our muscular actions. To define its nature has hitherto baffled the efforts of the metaphysician and natural philosopher, but assuredly we are not yet so far advanced in our knowledge of the system of the universe as to entitle us to declare that a great dynamical force like that of heat is on the wane."—Vol. i., p. 213, 10th ed.)

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"Verifier" questions the assertion of geologists that considerable portions of the dry land are rising at the present time as the result of "tranquil movements of elevation and depression." He argues that, "while the fact itself is doubtful, Geology can furnish no reason why it should occur, which is a strong *prima facie* argument against it." He says that no light is thrown on the time or mode by which beds of sea-shells of existing species have been deposited at various heights considerably above the Baltic, and "we cannot suppose that Wales is at present emerging from the sea merely from the discovery of sea-shells on Moel Trivaen, which may have been placed there before the creation of man. The question we have to deal with is confined to

causes now in action, and we seek to ascertain what is going on at the present time."

I suggest that the difficulties thus described are overcome if, to the causes now in action, as enumerated by geologists, we add that of growth. "Verifier" is most successful in his criticism when he attacks "the theory of the erosive power of running water, and the conclusion that the valleys, gorges, and beds of rivers, many of them composed of the hardest and most indestructible of rocks, in all parts of the world, have been cut by the streams now running through them, however inconsiderable." He observes that, "the writers of the modern school of Geology adopt this as the basis of cosmical operations. Their system cannot work without it; it is laid down in their elementary manuals, and reasoned on in the profoundest of their philosophical papers, and those who dare to doubt are treated with ridicule. . . . Those who dwell near the rushing waters of cataracts are unconscious of the abrasion of a single foot or inch within the term of man's memory. The frequent growth of water-plants, mosses, sea-weeds, &c., on the very surface washed by rapid currents, ought also to create doubts as to the truth of this prevalent notion. Its general acceptance seems to be due to the confounding together of certain undoubted fluviatile operations. . . . Many of the great river-valleys display miles of lateral precipice, rising often to heights of 1000 and 2000 feet above the water, almost invariably as smooth and even as the walls of a house. No proof exists of any of the processes of watery action above enumerated being able to produce straight cliffs, *i.e.*, walls of rock." He further says that, "the Prussian engineers, at any rate, had no faith in such aid in 1833, when they had some trouble in removing, by means of gunpowder, the well-known reef stretching across the Rhine at Bingen, upon which so many barges had suffered wreck during hundreds of years, to the injury and opprobrium of Hanseatic commerce. Yet notwithstanding the full stream of the Rhine during so many ages had been unable to wear away this comparatively slight barrier, we are taught by geologists to believe that the long avenue of lofty precipices, including the Lurley, a little lower down, and consequently the whole of the gorge from Bingen to Neuwied, 60 miles long, have been cut through this same river Rhine."

I may here observe that Lyell does not attach such exclusive power to the erosion of running water. On the contrary, he complains that Hutton and Playfair ascribe valleys in general "too exclusively to the action of rivers

now flowing through them, not allowing sufficiently for the excavating and transporting power which the waves of the ocean exert on land during its emergence," and to "those inequalities of the surface which must be produced by movements accompanying the upheaval of the land." Lyell is, in fact, criticised by Colonel Greenwood, in "Rain and Rivers," more after the fashion of a warrior than a philosopher, because he attaches too little importance to the "perpetual disintegration, denudation, and destruction" which is produced by rain and rivers; the Colonel holding the reverse opinion to "Verifier."

In the volume already referred to, I have shown how improbable it is that the present bed of the St. Lawrence has been formed solely by water erosion (*see* "Constitution of the Earth," pp. 300 to 303). "Verifier" argues that the retrocession of Niagara Falls arises from the fact that the St. Lawrence flows over a bed of limestone 90 feet thick, between which lie soft shales of equal thickness; the splash of spray wafted up from below the Falls dissolves the soft shale, and the hard limestone breaks away by its own weight. But he overlooks the fact that Lyell, during a visit to the Falls, "obtained geological evidence of the former existence of an old river-bed," which he had no doubt indicated the original channel through which the waters once flowed from the Falls to Queenstown. Why did the St. Lawrence leave its ancient bed to form a chasm 90 feet deep, through the hard limestone? I have suggested that, under the actual circumstances, running water could produce no such effect, but that the change in its course must have been due to a disturbance of the crust of the Earth consequent upon internal expansion. "Verifier" in this instance abandons his theory that river-beds have originated in a primeval split-up of the crust of the globe consequent upon contraction and shrinkage whilst it was cooling down from a molten condition. It is clear that the fissure through which the St. Lawrence passes cannot have originated "in events, issues, and developments which have passed away," or "on a different condition of our planet from the present;" the ancient water-course showing that, long before the existence of the one down which the water now passes, the surface of the Earth did not differ greatly from its present condition.

"Verifier" refers most successfully to the great cataract of the Zambesi, in Central Africa, as an example, on the largest scale, of a river-bed made *for* the river and not *by* it. "This commanding stream having attained a width of more

than a mile, flowing along an undulatory plain bounded by distant hills, on a sudden drops down into a crack stretching directly across its course, forming a trough 350 feet deep, but not more than 80 feet wide, into which the whole body of water is discharged. The Fall is twice as high and twice as wide as Niagara, but differs from it in that, immediately opposite the Fall, rise three successive natural walls of rock of the same height as that over which the river leaps, separated from one another by narrow rifts. These triple barriers consist of wedge-shaped promontories of rock, with vertical sides, projecting alternately from the right bank and from the left, like side-scenes in a theatre, but entirely overlapping one another. Out of the first deep trough the river, after its descent, is compelled to find its way through a gap only 80 yards wide in the first opposing rock wall. A second wall here confronts it, by which the stream is turned at an acute angle to the right. It is next forced round the second promontory, then reversing its course round a third, and before it is allowed to escape to the sea it is compelled to double round a fourth wider headland."

"Verifier" forcibly argues that no action or application of running water could cause a river of first magnitude, flowing over a flat surface of rock, thus suddenly to drop into the bowels of the Earth. The surging river is obviously confined and governed in its course by the remarkable fissure through which it has to pass; but when "Verifier" suggests that the fissure was possibly the result of "some shrinkage of the basaltic rock, when cooling down from an incandescent state," he certainly does not offer a more probable origin than may be found in the known effects produced by earthquakes or the suggested results of subterranean movements. It is a favourite idea with some geologists and astronomers that certain phenomena are to be accounted for by the contraction or shrinkage of the Earth's crust consequent upon the radiation of heat; and yet the sedimentary rocks of which it is largely composed supply no evidence to justify the conclusion that in former ages they were subjected to a temperature greatly different from the present. Recent experiments, moreover, by Herren Nies and Winkelmann, show that the common idea as to the expansion of bodies by heat and their contraction on cooling (with the notable exception of ice) is erroneous. It has been found that silver, tin, zinc, iron, copper, bismuth, and antimony all expand when taking the solid form. The effect upon some of the other metals has not been clearly ascertained; but, as in the well-known case of ice, careful experiments justify the con-

clusion that the metals, as a rule, expand, and certainly do not contract, in solidifying.

Mountains in all parts of the world are split through to allow rivers to pass, observes "Verifier," and he instances the Litany, a river of Palestine, which if left to itself, according to the laws of Hydrostatics,—instead of cleaving the Lebanon to a depth of 600 feet, in places not more than 10 or 15 feet wide,—must have followed the lower opening presented to it, and passed into the Dead Sea. He asks, "Why should the Avon on quitting Bristol have altered its course, and, instead of running straightforward over the low ridge of Bedminster into the Bristol Channel, have turned north to encounter hills five times higher (400 to 500 feet), those of Leigh Downs, unless it had found the gorge of Clifton opened ready for it?" He argues that the gorge must have been produced by a "great convulsion," because the strata at one place has suffered a vertical displacement of 800 feet above those of the other. I would say that it has resulted from internal expansion consequent upon growth, and I can show him a precisely similar "convulsion," on a small scale, as the effect of growth upon the bark of a pear tree. The "upheaval" on one side of the crack, in the latter case, is indeed relatively much greater when the size of the trunk of the tree is compared with that of our globe. "Verifier" is more successful in suggesting that, when ravines have the strata on one side either lifted higher or sunk lower than those on the other, such phenomena cannot have been produced by the erosion of rivers, but are undeniably faults or fractures in the strata.

From the foregoing it will be evident that the author of "Scepticism in Geology" attaches much less importance than is usually assigned to denudation in connection with the present conformation of the surface of the Earth. His criticism, it may be objected, assumes an unwarranted degree of severity, especially when considered in connection with the rival theory which he propounds in substitution of "modern causes." "It is surely time," he exclaims, "that common sense should be exercised to resist the fallacy that weather, frost, ice, and running water (such as we now experience), could have carved out mountains, dug valleys, swept away piles of strata miles high, or strewed hills, valleys, and plains, all over the world, with streams of loose stones, including boulders as big as a house, gravel, clay, and earth. The reliance of modern Geology upon such feeble and inadequate agencies to produce such enormous results may perhaps be accounted for by the fact that a

teacher of this new philosophy assures us both that *time* is *power*, and that to attribute great effects to great causes is a prejudice." I have already suggested that time is simply an abstract conception of the changes which are continually going on in Nature. Time, in fact, represents the united forces (or the sum total of all the forces) of Nature. Whilst, therefore, time, apart from these forces, is a purely metaphysical idea, and can do nothing, as the representative of these forces it is omnipotent, having for its origin the Great Mover of the Universe. When we say that time will convert the sapling into a tree, we do not mean that the mere tick of the clock, or a number of rotations of the Earth upon its axis, will transform the sapling into a tree, but that certain forces or conditions, acting according to the order of God in Nature, will produce such a result. Take away the life of the sapling, and the rain and dew will fall, the sun will shine, and the air and soil will encompass it, all in vain.

Behind all the other forces recognised by geologists as having played important parts in producing the changes which have taken place on our globe, lies that of vital force, to which all the others are subservient. This is the force so sagaciously surmised by Lyell when he asks "What is the origin of the force which governs the motions of the heavenly bodies?" and which, he observes, "has been likened to the intellectual power of the human will, which initiates and directs all our muscular actions." Admit the presence of vital action in the form of growth, and all the conflicting theories to account for the changes which have taken place on the Earth's surface are reconciled. Electricity, magneticism, earthquakes, volcanoes, heat, and other "modes of motion," may be described as physiological processes due to or connected with vital action, whilst the fall of water, denudation, river erosion, sedimentary deposits, &c., are the mechanical effects; the whole being illustrative of "the unity of Nature." The slow expansion of the more plastic matter of the interior of the Earth has acted upon its crust like the growing tissue of a tree upon its bark. Cracks, and subsequently fissures, have thus been produced where the crust has been of a dry unyielding nature. These fissures have, in numerous cases, slowly widened, and become water-courses; and, where the material of the sides has been of a soft nature, it has, under suitable circumstances, been simultaneously corroded by the action of air and water, assisted by a changing temperature. The loose material thus produced, having been carried by successive

rains down the sides of the fissure, denudation has slowly assisted expansion in producing the slopes which are characteristic of the valley.

In some cases the expansive force has acted unequally upon the sides of a crack in the crust of the Earth, and one side has been "thrown up" higher than the other. Hence huge masses of strata are sometimes exposed, whilst the corresponding side of the crack can with difficulty be discovered. In other cases, where a similar effect has been produced, the upheaved side, having apparently been simultaneously with its slow elevation denuded by its exposure to air and water, cannot be distinguished on the surface. Upheavals, like the latter, are common in the North of England, and are sources of great trouble and expense in connection with coal-mining operations.

We have thus an explanation of the fact unexpectedly revealed by the *Challenger* Expedition, that the bottom of the deep ocean is not, as was commonly believed by geologists, covered by the sediment carried down by rivers, but by accumulations of the shells of microscopic animals which have lived at or near the surface. Denudation has not taken place to the extent that was supposed, nor has all the matter thus carried down the sides of gorges and valleys found its way into the ocean. A large portion of it has served to fill-up constantly widening cracks and fissures, or to form the slowly extending alluvium of valleys consequent upon the Earth's expansion.

In order, however, to understand more perfectly the changes which have taken place in the Earth's surface and its present state, we must imagine its condition before the era of water and sedimentary deposits; we must take lessons from the Moon and from our younger sister-planet, Venus. In an article which appeared in the "Journal of Science" for January, 1877, Mr. Edmund Neison, F.R.A.S., observes that, "many eminent physicists and geologists have recognised that the present condition of the surface of our satellite promises to throw much light on many vexed geological and physical problems. The opinion of that eminent geologist, Prof. Phillips, on the subject is well known, for he has often expressed his conviction that the lunar surface presented the best field for the study of many of the more difficult problems of Geology." Mr. Neison further says that, "It is a remarkable circumstance, in relation to the question, that whereas those astronomers who have devoted much time and labour to the study of the Moon's surface, and to whom astronomers in general are mainly indebted for

our present knowledge of the surface of our satellite, hold in general one view as to the present condition of the lunar surface, astronomers as a body hold a different opinion. To take a striking example: scarcely any astronomer known to have devoted time to the study of selenography doubts that many processes of actual lunar change are in progress, and it is doubtful if there is one who could not promptly instance one or more such cases. Yet the general opinion of astronomers appears to be against any such physical changes having occurred."

Extensive changes in the Moon suggest something of the nature of life, or vital action, and are therefore inconsistent with the mechanical view of the universe. Even scientists, though professing to be philosophers, do not easily believe disagreeable truths. More than twenty years ago, in a book entitled "The Earth we Inhabit," Captain Drayson showed that, whenever a base line had been measured a second time after a considerable lapse of years, the later measurements did not agree with the earlier, but were *greater* in every case. I am not aware that his statement has ever been contradicted, but astronomers still keep telling us that the Earth is *contracting!* Whenever the distance of the Earth from the Sun has been measured in connection with the transit of Venus, the latest measurement has always shown an increased distance between the two bodies; yet astronomers still insist that, instead of receding from, the Earth is *advancing* towards, the Sun! Mr. Neison need not, therefore, be surprised that astronomers refuse to recognise the facts which are vouched for by selenographers to establish the physical changes which are taking place in the Moon. I gather from his article that appearances have been discovered which suggest the probable existence of obscure processes of vegetation, but that its surface—which is in a more plastic, and therefore more changeable, condition than that of the Earth—consists largely of gloomy valleys (or "craters" and sterile mountains. The lesson is simple if my view of planetary creation is accepted. The Moon is an off-shoot of the Earth by natural processes still in operation, as the latter is an off-shoot of the Sun; and the Moon's present condition may be supposed to represent that of the Earth in the earliest stages of its history, when vegetation and sedimentary deposits, if any, had a very limited existence.

The planets Venus and Mercury, being nearer to the Sun, and therefore, according to my theory, correspondingly later in the order of creation than the Earth, will also illustrate its condition in remote ages. In consequence, however, of

their brightness, and being surrounded with atmospheres, we do not possess much information as to their surfaces; but it is believed that their mountains are relatively very much higher than those of the Earth, and it has been calculated that some exist in Venus between 20 and 30 miles high. If we could remove the waters of the ocean, and the sedimentary and other stratified deposits, the valleys of our globe would be some 6 miles deeper and the mountains correspondingly higher than at present. I believe that such inequalities are sufficient to account for the evidences of great heat and great cold in the earlier periods of geological history. The high or low degrees of temperature in any latitude is greatly a question of the depths of the valleys or the heights of the mountains, as demonstrated by the fact that, even in tropical regions, high mountains are perpetually covered with snow. It is not necessary, therefore, to imagine the existence of periods in which extreme heat or extreme cold alternately ruled upon the Earth. The great depths of the valleys and the great heights of the mountains in former ages will also help to explain the alternate depositions of coal, clay, gravel, sand, &c., which have taken place over the same areas. In such a condition of high mountain and deep valley in connection with the development of water, the deeper valleys would be liable, at intervals, to be overwhelmed by the breaking away of the waters of lakes or seas which existed at higher elevations. It has been supposed that, when the vegetation of the coal-measures was in the course of growth, the air was hotter and moister than at present. The presence of deep valleys in which such growth was favoured would account for such local condition of the atmosphere without the necessity for imagining a period of tropical heat over the entire globe. This greater contrast between valley and mountain would also account for the transport of large blocks of rock and other evidences of "glaciation" described by geologists. Curiously enough the belief in a "great ice age" is not unfrequently entertained in connection with the theory of radiation into space consequent upon the cooling-down of the Earth from a red-hot molten condition; as if such mechanical radiation had unaccountably stopped for a period and afterwards as unaccountably again commenced! With Immanuel Kant and Laplace I believe that the various substances of which the Earth is constituted once existed in a gaseous state, but with Lyell I see no reason to doubt that the forces by which the transformations have been made are the same in kind and degree as those which are now in operation.

IV. THE PHILOSOPHY OF PAIN.

By FRANK FERNSEED.

EVEN in these enlightened days the world is not content to ask what is, and how it is, but will persist in raising the much more difficult question, *why?* High authorities, leaders in methodology, from time to time rebuke us, pointing out that all such inquiries are not merely of doubtful solubility, but scarcely admit even of being scientifically stated. All this is in vain: mankind will persist in assuming the existence of a purpose in natural phenomena of the most varied orders, and in striving to trace out what that purpose may be. If, however, the subject I have ventured to take up is essentially illegitimate, I must crave the pardon of my readers for attempting to do what is done in thought even by those who turn away from it openly, as a mere waste of time and thought.

Pain has, next to its frequent companion, moral evil, ranked first among the shadows of the world we inhabit, until both, and much more, were summed up and comprehended under the modern name of the "struggle for existence." The question has again and again been raised, by saints and sages, as well as by every-day mortals, why a world in many respects so fair should be over-clouded with this almost omnipresent evil; why life can neither begin nor end except at the price of suffering? The answers have been various, satisfactory to their propounders, but rarely to the looker-on, least of all to the sufferer.

I remember a thinker, or perhaps dreamer, who maintained with great vehemence that pain was the normal and natural state of man, but that it only became an evil if we refused to accept it as our lot. I will not attempt to reproduce in English the somewhat misty arguments by which he strove to uphold his doctrine. Suffice it to say that he was nowise less eager to avoid this supposed natural condition than are other men, and that he was certainly not averse to any physical enjoyment.

There is a school of neo-stoics who take a view in some respects diametrically opposite. They contend that pain exists only in our own imaginations or in the feebleness of our will. Had we sufficient self-control pain would not merely be no longer an evil, but for us would cease to exist.

To criticise this theory is scarcely possible except we possessed the power of projecting our consciousness into the inner life of those who make this assertion. Possibly they may, from some constitutional peculiarity, have less sensitive nerves than their neighbours. Perhaps they may be able, by the mere force of will, to throw themselves into a state resembling catalepsy. We read of men who in the olden time were submitted to torture "for their souls' health," but who whilst on the rack seemed unconscious of what they were undergoing. But it seems to me that all immunity from pain due to such causes, as well as to delirium, drunkenness, violent passion, and the like, must be merely temporary. I have indeed known persons who had embraced, verbally at least, this stoical theory, found themselves yet unable to dispense with medical aid when suffering, *e.g.*, from tooth-ache or from neuralgia. It is therefore but fair to infer that what exceptional persons may possibly have once and again accomplished, in some state of exceptional excitement, signifies little for the mass of mankind. To them pain is a reality, to be dealt with by physical means only, and no more to be overcome by any psychic effort than are hunger and thirst.

The favourite theory concerning pain is due to the so-called "natural theologians." It views pain as a necessary evil, depending on the constitution of man and of the universe, and as being in its purpose benevolent. It is not a random, purposeless torment; still less is it punitive or vindictive. It is a self-acting natural contrivance for warning man—or rather animated nature altogether—against whatever might imperil the health or the life of the individual, and in consequence lessen the probability of the race or the species. Without its beneficent guidance we should rush to destruction.

These views were expounded with some wealth of illustration in a work which in its day was considered as heterodox enough, the "Constitution of Man," by G. Combe. They are adopted, with some slight transposition, by not a few Evolutionists, who, whilst denying purposiveness in the universe, seem to work round in an indirect manner to what is substantially the same thing.

Let us now examine this "warning" theory. It is the part of an efficient watchman to raise the alarm on the approach of any and every kind of danger; to let his warnings be proportionate in their urgency to the magnitude of the approaching mischief, not to raise a startling outcry if he espies a mouse entering the premises, and merely utter

a scarcely audible call if a fire is breaking out, or if a gang of burglars are picking the lock of the door. If worthy of the name he will also see to it that his danger-signal is not in itself an evil as great as, or perhaps greater than, the calamity to be warded off. He will not, *e.g.*, set fire to a corn-stack by way of making it known that a weasel has crept into the hen-roost. Above all, he will not keep silence till some mischief has been done, and summon the household after the enemy has made good his escape.

Let us examine in how far Pain, the self-acting watchman, answers to these very natural requirements. A man approaches his hand to a fire; he experiences the agreeable sensation of warmth. Encouraged by this he advances his hand nearer, and the feeling becomes slightly—perhaps very slightly—unpleasant. If he disregards the warning and approaches still nearer, he experiences decided pain, which grows more and more intense, till he reaches the climax of torture as he touches the glowing coals or allows the flame to play over his hand. If he still persists, the destruction of the member and grave peril to the entire system follow.

Here, therefore, the action of the "watchman" is, as far as we can perceive, perfect. An alarm is given at the very faintest approach of danger, and becomes gradually stronger and stronger as the peril increases. We must grant that if man, whether in consequence of specific creation or of evolution, were not unpleasantly affected by the near approach or actual contact of burning matter, he would be much more likely than at present to fall a sacrifice to the use of fire.

Again: I lay my hand quietly upon a hard substance—say a stone, or a bar of iron. I feel resistance, but nothing to be called pain. I repeat the experiment, bringing down my hand upon the object with some appreciable force. I at once experience pain, the more severe the heavier has been the blow. If I disregard the warning, or if I have no sense of pain and thus cannot perceive it, and if I strike still more violently, the hand may be bruised or shattered. The case is quite similar whenever we come in contact with any hard, rough, or sharp object. In all these cases the warning is in its nature perfect, never-failing, and strictly proportionate to the exigency. We never feel more pain from the gentle touch of a hard object than from the violent blow. If we were deprived of this susceptibility to pain we should not be gainers, but losers. It is highly probable that, should a race of men or an animal species spring up who were not unpleasantly affected by contact with fire, with bodies which can cut, pierce, or lacerate, their chances of survival and

multiplication would, in accordance with the doctrine of Natural Selection, be decidedly small.

But we must not stop here. How is the case with internal diseases of the human system? In all affections of the inflammatory class pain is an essential and substantially never-failing feature. The sufferer is duly warned that something is amiss with him, and may at any rate seek means for relief. Here, too, it may safely be contended that the severity and acuteness of the torment is fairly proportionate to the urgency of the danger; and it must also be at once granted that if acute disease of the vitals were unattended with pain, and were consequently liable to be overlooked, the change would not be beneficial either to the individual or the species.

Now, however, we meet with facts of a totally different class. There are not a few diseases of the most serious character where nothing like pain is ever experienced, and where the sufferer consequently goes on in his usual course, totally unaware of any danger, till he falls down dead, or is at least completely prostrated. Everyone must have met with the statement—stereotyped we might almost call it, in cases of apoplexy—that "the deceased was apparently in the enjoyment of perfect health." Surely a disease indicator which does not act in affections of the brain and the heart is very far from perfect. It might be contended that in these very diseases a warning might be more beneficial than in acute affections. In the latter the alarm is often, in fact, too late, unless efficient medical aid is at once procurable. But if a man were made aware by any signals that morbid changes were in progress in his heart or in his brain, he might modify his way of living and avoid whatever is likely to foster the disease. It is not too much to say that many a person might prolong his life by merely avoiding excitement, if he were only warned of the necessity of thus acting. But here, where the danger is extreme, and where a caution might save, the "watchman" makes no sign! Pain, therefore, is not a general warning against all physical perils, even the most urgent. Just as conscience in case of moral diseases, so pain in bodily derangement is merely a partial and irregular monitor.

We may pass now to an example almost diametrically opposite in its character. The decay, and even the ultimate loss, of a tooth is of but little moment. Yet few pains are so violent, so prolonged, so utterly distracting as tooth-ache—the warning which the "watchman" employs to inform us that there is something wrong with one of our grinders. For so slight a cause a man may for months be deprived of

due sleep, be hindered in taking food, and to a great extent incapacitated for his business. In this case we find almost all the characteristics of the efficient watchman either absent, or it might even be said reversed. The alarm, especially if we compare this case with the painless approach of apoplexy, is inversely as the danger. The warning given is in itself a far greater evil than the mischief to be warded off. The result, moreover, is in the majority of cases not the preservation, but the loss of the part affected. Thus all the suffering experienced practically goes for nothing. It can scarcely be contended that man gains anything by the extreme sensitiveness which the nerves of the teeth possess. Should a variety of the human race spring up in whom these nerves became insensible on the first approach of decay in the teeth, such a race would, *pro tanto,* fare not worse, but better, in the struggle for existence.

I have, in accordance with a very generally-received opinion, pronounced the sensitiveness of man to the contact of external objects a safeguard against a variety of dangers. But even here there are certain limits easily and often exceeded, beyond which this sensitiveness, so far from being an advantage to its possessors, becomes a serious drawback. It is well known that in all those parts of the world—tropical, temperate, cr arctic—where mosquitoes, sandflies, &c., are numerous, they form a very tangible obstacle in the way of man's "replenishing and subduing" the world. It is also on record that sensitiveness to the bites of these and similar vermin varies greatly in different persons. Whilst some experience merely a very slight irritation, which quickly passes off, the bites in others occasion swellings and inflammation of a very annoying character. I know of cases where the attacks of the common English midge have rendered medical treatment necessary. On the other hand, I enjoy immunity from the bite of *Simulium columbaczense,* one of the most dreaded of these tiny marauders. Seeing, therefore, how greatly human susceptibility to gnat-bites can vary, it is at least conceivable that a strain of our species might some time arise who would experience no annoyance from such insects. It is beyond all dispute that in many parts of the world such a race would, *cæteris paribus,* possess a decided advantage over ordinary mortals, and would have a natural tendency to preponderate in all regions infested with mosquitoes. Extreme sensitiveness to heat, to cold, to wind, &c., is also no safeguard or advantage, but a decided element of weakness.

Hence we see that the susceptibility to pain in animals,

and especially in man, is of a very complex character in its results,—not always good, nor always evil; sometimes a friend, and sometimes useless, if not hostile.

Such being the facts, we may well pause before pronouncing it a principle divinely implanted for our preservation, or, viewing the case from another side, before concluding that it has played a fundamental and favourable part in human development.

There are those who assert that pain is merely an intensification of feelings which in their normal degree are pleasurable. This view holds good perhaps alone in the case of temperature, where a certain range not differing greatly from the heat of our own bodies is pleasant, but becomes more and more painful, and even deadly, as it rises above or sinks below this standard. But this heat-sensation is perfectly exceptional and unique in thus changing its character in accordance with its degree. The gentlest contact with rock or iron bar, with the point of a thorn or the edge of a knife, is certainly not painful, but as certainly not pleasant. Or take the sensations of acute disease; they are no intensification of any ordinary normal state. When in perfect health we are simply unconscious of the very existence of those organs which when diseased become the seat of intense torment. There is no transit from pleasure to pain, for those parts are never the seat of pleasure. Two points must here indeed be noted—the greater intensity of pain as compared with pleasure, and the far wider scope which the former possesses in the animal body. What physical delight can be for a moment likened in its height to the pangs of tooth-ache? There is no part, internal or external, which may not become the seat of pain, whilst how few are ever, or can ever become, the seat of any positive pleasure!

But this last word reminds us of a new difficulty. If pain is a warning mark or consequence, attached to certain actions that we may carefully avoid them, and if the growing violence of pain—as in the case of putting our finger in the fire—is an evidence of growing danger, we might not unnaturally expect that pleasure would be a characteristic mark of whatever is safe and salutary—the more salutary the more intense the delight.

But how does this conclusion agree with experience? Have we no foods delicious to the taste, but of doubtful digestibility or wholesomeness, sometimes even positively poisonous? Have we no beverages, of pleasant flavour and aroma, but which some authorities condemn altogether, whilst others declare them dangerous, except used with

great caution? Have we no climates, exhilirating, soothing, balmy, but where the air is laden at once with perfume and pestilence? Do not our moralists universally bid us beware of pleasure? Is it not, then, strange that the two opposites, pain and pleasure, should both be signals of danger or marks of what must be approached with caution? What can here be the hidden purpose? It seems to me that no philosophy of pain can be constituted unless it is able to solve this capital difficulty—a difficulty equally formidable to the advocate of special creation and to the evolutionist. But in the meantime there is nothing in the warning or beneficent theory of pain which can command our full assent. It explains certain cases in a satisfactory manner, but it breaks down in others.

The last theory of pain that I shall mention is one now almost abandoned, though for centuries it met with general recognition. It regards bodily suffering not as an original and essential feature of the universe, but as a consequence of moral evil. How deeply this notion is, or at least was, rooted in the human mind is apparent from the history of language. Philologians tell us that the very word "pain" means originally "penalty" or "punishment." I shall perhaps be voted old-fashioned for even adverting to such a theory. But it seems to me that if pain has in it anything of purpose, and has been ordained by a conscious Intelligence, the phenomena of the case agree better with this view than with any other.

V. THE WEIGHTS AND MEASURES QUESTION RECONSIDERED.

By An Old Technologist.

SURELY all rational controversy between the old and the metric systems of weights and measures is by this time over. The last word surely has been said, and there remains for the upholders of our present standards merely a dogged determination to cling to things as they are, or at the best a hesitation in face of the great inconvenience

which a change would bring to the present generation, and to the sacrifice of the not inconsiderable capital invested in weights and in measures of length and capacity!

Such is a very fair specimen of the language used by advocates of the metric system. Such is the language I have myself formerly used, for I have in my day been the duly appointed "Hon. Sec." to a certain local committee for the introduction of the metric system into the United Kingdom. As the said committee, after electing its officers, never again could be got to meet, I am not very gravely committed to the movement.

But setting such mere personal considerations on one side, let us see whether in this case all is really gold that glitters, —whether such truly scientific men as the late Sir John Herschell, in opposing the projected reform, were actuated by no better feeling than what we, for want of a more appropriate name, term "mere conservatism."

I will begin with some very ample concessions. I will at once grant that two scales of weight, like the Troy and the Avoirdupoise, bearing no definite or simple relation to each other, are not to be defended. I will admit, as evils, that we have two linear measures, the one for length in the abstract, and the other for what it is now the fashion to call "textile" goods; that our measures for superficial extent, *e.g.*, land, are not simply the squares of either of the above, and that our measures of capacity are not the same for liquids and for solids, and that neither of them is correlated with our standards of length. Foreigners ask us occasionally, not unjustifiably, how any rational beings can tolerate a system of measures where the unit of a higher denomination is not the product of the lower by a whole number, as in the case where 16½ feet make 1 statute pole. To do away with these inconsistencies would be something more than a mere sacrifice to our love for logical symmetry and consequence—if, indeed, we Englishmen have any such feeling, and not rather its opposite. We are told to think what the metric system offers us in the way of tangible convenience and saving of labour. It sets out with the metre, originally, but—as it has since been discovered—erroneously, supposed to be the ten-millionth part of the length of a meridian from the Pole to the Equator. From this one basis the whole system of measures and weights flows as a connected whole. Square the metre and its multiples, and we have the measures of surface, no matter to what they are applied. Cube the metre, and we have the standard of capacity for liquids or solids. Fill such a cube with distilled water, and weigh it,

and we get the unit of weight. It is plain that the introduction of such a system would do away at a stroke with the so-called "compound" rules of arithmetic, and with the "tables" so laboriously instilled into children—a consideration of no small weight in these days of School-Boardism. It would, beyond all doubt, greatly reduce the amount of work in commercial houses.

I have heard it maintained, by highly competent judges, that were a decimal system of weights, measures, and money introduced, our great bankers, merchants, and manufacturers might dispense with one clerk out of every five. It is, further, beyond a doubt that the adoption of the metric standard would much facilitate all transactions with the countries where it is already established, *i.e.*, all Europe, except Turkey and Russia.

But the great question remains, how would it act in retail trade in those transactions which, though individually small, come home to every one in the routine of daily life? Here I must confess that there are some features of the metric system, not necessarily involved in its two fundamental principles, which I look upon with distrust, as likely to work badly in the hands of the great body of the people. If we look at our traditional system of weights and measures we find that their names are short,—with few exceptions monosyllabic,—inch, foot, yard, mile; grain, drachm, ounce, pound, ton; gill, pint, quart, &c. Now if we glance down a table of metric weights and measures we find different grades expressed by words of three, four, or even five syllables. Some of these names, too, are annoyingly like each other, and liable to be confounded together, as decimetre and decametre, decilitre and decalitre, decigramme and decagramme. The fact is that the French commissioners made a great mistake in selecting "classical" names for their weights and measures, which they considered might be adopted by other nations without translation.

Further, the numbers used in our system as factors and divisors are mostly small, and easily dealt with in the mind. Two, four, six, eight, or ten ounces of anything are magnitudes easily remembered. Nor, if we know the price of a pound, is it difficult to reckon mentally what is the price of each of these quantities. But suppose we take their approximate metric equivalents, 58, 116, 174, 232, or 290 grammes: here are numbers much less readily carried in the memory.

In calculating the price, too, there is the same or a greater difficulty. If 1 lb. of "coffee as in France" costs a shilling,

there are few children old enough to go on an errand who cannot calculate the price of 4 or 8 ounces. But if asked if 1 kilo. of any article costs a franc, what should be paid for 116 or 290 grammes? many of us—not children, nor exceptionally ignorant—would feel somewhat puzzled. The metric system in its present form brings us in contact with numbers beyond the reach of the multiplication table, and we consequently require the aid of paper and pencil to cast up the results. The fact is this system, as at present organised, is not decimal, but centesimal or millesimal. One thousand grms. make 1 kilo., the two intervening denominations (the decagrm. = 10 grms., and the hectogrm. = 100 grms. or 10 decagrms.) being practically never used. The same holds good of the measures of capacity, the decalitre or hectolitre. I can safely say that in the thousands of French, Belgian, and German receipts for dyeing, printing, or colour-making which have come under my notice, I have never seen any denomination of weight between the gramme and the kilo., or any denomination of measure of capacity above the litre.

It is just the same with money in the countries of the "Latin Union." Between the franc and its hundredth part, the centime, there is no intervening denomination.

Further, in our old traditional English system we can express very small quantities, weights, or measures, by whole numbers. A grain, a grain-measure, a line, are quantities below which it is rarely necessary to go, save in refined scientific investigations, in the manufacture of instruments of precision, &c. For the purposes of daily life and for retail trade nothing smaller is wanted; but in the metric system the smallest magnitudes which are expressed in integers are much larger, and that in a mutually disproportionate degree. The smallest weight written as a whole number is the gramme = 15·438 grains; the smallest measure of capacity is the litre = 1·76 pints; and the smallest measure of length is the metre = 39·37 inches. Here, surely, is inconvenience and inconsistence,—the less to be tolerated as occurring in a system which takes its stand upon strict consistency!

It may be contended that these high values for the lowest denomination are not a disadvantage. I reject such contention. The higher is fixed the smallest denomination expressed in whole numbers, the sooner we are driven into the realm of fractions,—decimal fractions, as a matter of course. Now such fractions, however convenient to deal with, pen or pencil in hand, are most perplexing for mental calculation. Except we possess exceptional arithmetical powers,

we forget where to put the decimal point, and of course get bewildered!

It may be said that centesimal and millesimal reckoning becomes easy to the great mass of the public with practice. Experience does not prove this to be the case. A writer, whose name we forget, has pointed out—what any traveller in France may verify for himself—that when the process of ticket-giving begins at a French railway-station, an official takes his stand at the window to tell the booking-clerk within and the passenger without what two and a half return tickets at 1 franc 65 centimes come to. French money would be much easier added up if, instead of two columns only for francs and centimes, there were three, for francs, tenths of francs (which I may provisionally call pence), and centimes.

Again, it is a remarkable fact that in all the countries which have adopted the metric system, vulgar fractions, though denounced as heterodox, creep in. Who has not heard, in the shop of a French grocer, &c., customers asking for a "mi-kilo." of sugar or coffee? Indeed, in some countries which have adopted the metric system, this "mi-kilo." (= about 17 ounces) figures as a metric pound. In receipts and formulæ of all kinds I very frequently find such quantities as the quarter, the third, and even the thirty-second, of a litre specified.

Sir John Herschel maintained, not without grounds, that successive halving is an instinctive propensity of man, and that consequently any system which discards halves, quarters, and eighths must be regarded as unnatural. Of this we have a very good instance in the 112, 56, 28, 14, 7, and $3\frac{1}{2}$ lb. weights used in warehouses and shops, and it is said that some tradesmen have even memorialised the authorities to allow the use of a $1\frac{3}{4}$ lb. weight!

The nomenclature and the notation of the metric system seem to me to want reorganising. It requires plain, short, simple names for its various grades, to be expressed in such a manner as to banish the decimal point beyond all ordinary transactions. It needs, too, terms for the half, the fourth, &c., of its chief denominations. The various names, so long as they express one and the same thing, need not be identical in different languages. If we call the 17 oz. weight pound in English, livre in French, lira in Italian, and pfund in German, any one of these terms is surely more convenient than 500 grammes.

It has been said that the universal adoption of the metric system would facilitate business. But it should not be forgotten that, in consequence of the development of

protectionist principles, our business with the metric countries is not likely to increase, and it may become at least an open question whether under these circumstances such facilitation of business may not be in certain cases undesirable.

There is one department in which a step in advance might be taken by the supercession of all systems of weights, and the adoption simply of "parts." In all receipts, prescriptions, or formulæ of every kind, such "parts" should be the sole standard, everything being expressed by weight. Every person using the formula would refer these "parts" to his own standards, whether these were grains or grammes, pounds or kilos. In this manner all fractions are avoided. I fear that the spread of the metric system has acted unfavourably upon this simplest of all methods.

There is another way of drawing up receipts common in America, and exceedingly simple. The ingredients to be used are expressed as a percentage on the substance to be operated upon. Thus, suppose it is desired to dye 100 lbs. wool a cochineal scarlet, the receipt directs us to take so much per cent of cochineal, oxalic acid, chloride of tin, flavine, &c. It strikes me that the percentage system might be extended to medicine. Physiologists find in their researches that a drug becomes poisonous, or exhibits some lower degree of activity, when it bears such or such a proportion to the entire weight of the animal to which it is administered. Perhaps it will be found that the weight of a sick person furnishes the scale of the doses of medicine which may be usefully given.

For strictly scientific purposes I fail to see that the gramme, the litre, and their multiples and sub-multiples, have any advantage over the grain and the grain-measure.

The introduction of the metric system into retail trade, especially without the re-organisation I sketched out, would prove not merely inconvenient, but positively injurious to the great body of the nation, especially to the working-classes, since certain "pushing" tradesmen would not fail to utilise the new and imperfectly-known weights and measures as a basis for imposition.

There is a further consideration:—Hitherto we have been utterly unable to enforce unity of weights and measures on the old system. A peck of potatoes, apples, &c., is 20 lbs in Lancashire, 21 lbs. in Sheffield, 14 lbs. in Huddersfield and 16 lbs. in Halifax. A stone of anything is in some districts 14, and in others 16 lbs. The gill is in the North of England half a pint, but in the South only a quarter.

Almost every county has its peculiar acre, and in some parts land is measured by "day's works."

Not further to multiply examples, it would seem, judging from these facts, that to introduce a new system of weights and measures into general and exclusive use would require an amount of official interference and espionage which the nation would be apt to resent.

ANALYSES OF BOOKS.

The New Truth and the Old Faith. By A Scientific Layman. London: C. Kegan Paul and Co.

The conflict, real or supposed, between modern science on the one hand and religion on the other, seems to be gaining increased importance. We have able writers who seek to reconcile these two great powers; we have others who are zealously striving to widen the breach. This latter tendency is much to be deplored, whether it appears in *savant* or ecclesiastic. We must never forget that Science is in a state of rapid change,—that many of her theories are merely tentative, and contain much that, however probable, is far from being actually and conclusively demonstrated. On the other hand, our interpreters of Revelation are not altogether guiltless of the charge of clinging to the letter rather than to the spirit. They forget the grand principle laid down by Galileo, that the Scriptures are not a geological, biological, or physical revelation, but that on all such questions they convey, for the most part, the ideas of the ages when they were written. It seems to us that if we possess our souls in patience we may see some of the ominous discrepancies and apparent contradictions vanish away. We doubt whether, in this country at least, those who are foremost in real scientific work are anxious to "banish God from this our universe." That part is played rather by men who hover about the battle-fields of Science somewhat like Hotspur's fop on the plain of Holmedon, and who earn reputation by utilising the brains of others.

The author of the work before us is evidently a man of Science, and no less evidently a Theist and a Christian, and he comes forward with the laudable object of harmonising, if possible, the "conflicting ideas which are floating in the minds of the younger generation," or at least showing distinctly what are the points at issue. To this grave task he brings an evident love for truth, and an amount of learning which it would be idle to disparage. He accepts, provisionally at least, Evolution, but like ourselves* he regards it as God's way of creation, and as by no means irreconcilable with the existence of design in the Universe.

The work opens with an Introduction, in which the results of modern research are clearly summarised. He notices, without criticising, the strange theory of Prof. Helmholtz and Sir W. Thomson, that the first germs of life may have been brought to

* May we not say like Darwin and Lamarck?

our earth on a meteoric stone from other realms of space. But how did it originate in those other realms?

The definition which the author gives of species we are unable to accept, since the existence of fertile hybrids is now placed beyond all doubt. The body of the work is an answer to the three great questions, Whence, What, and Whither? He asks, "What is the mysterious tendency to minor variations from the special type in individual animals,—what but the inherent and God-given propensity of the organism to strike out a new form or to adjust itself to its environment?" Certainly we are not able to account for this tendency to vary, unless implanted in the organism; and by whom implanted? It has been shown repeatedly, in the "Journal of Science" as well as elsewhere, that Natural Selection must have incipient variations to work upon. It has even been asked whether the "struggle for existence" does not tend rather to reduce than to increase the number of species? Wo find in this connection a statement which we feel bound to reject:—"Until man appeared, all animal life was guided by instinct." There are few working naturalists who do not admit the rationality of the lower animals, though of course on a very limited scale.

On p. 87 we find the remark:—"The newly-introduced flora fed on the inorganic world, and purified the foul atmosphere; while a fauna came after to feed, in its turn, on the vegetation, and breathe the purer air." This passage seems scarcely in harmony with what we read on p. 34:—"Geology shows that although vegetation developed more rapidly than animal life, they progressed together." But throughout this first section we must pronounce the author's general line of argument as, in our judgment, sound. We feel little difficulty in endorsing the words in which he sums up this part of his considerations:—

"Evolution leads us to take an infinitely grander, though more visionary, view of the universe than Genesis reveals. Instead of a series of separate pictures, it presents us with a continuous panorama of creation. It shows us Nature as an intimate union of beauty and fitness, a pageant to the sense, a mechanism to the intellect; and in striving to survey this mighty plan the imagination seems to get a glimpse of the sublime truth that Cosmos realises the poetic dream, the transitory Art of God."

The two succeeding sections, "What?" and "Whither?" contain much into which we cannot legitimately enter in these pages, and not a few passages upon which we must beg to differ from "A Scientific Layman." Thus he writes—"By far the greater portion (of the earth) is made up of six of these, namely, oxygen, hydrogen, nitrogen, carbon, sulphur, and phosphorus." Sodium, calcium, aluminium, silicium are certainly present in far larger proportions than phosphorus if not than sulphur also. Nor can we assent to the statement that animals contain no cellulose (*see* Schœrer, "Ann. Chem. Pharm.," clx., 312).

The hypothesis advanced by some recent writers, that all matter is in some sense alive, the author pronounces "the wildest notion that ever emanated from a bewildered materialist." The probability of man "giving place to a superior animal evolved from him grows," he thinks, "very small." The following reflection is happy:—"God did not make the world beautiful that we might enjoy it, but rather He constructed us so that we could see and appreciate the beauty of the world."

Passing over the chapter on Free Will as scarcely within our competence, we come to the consideration of Evil.

Our author finds himself unable to accept literally the "biblical account of the Fall," which he considers "inconsistent with the development theory." It would seem, however, to some of our friends that the world gives actual indications of a great change for the worse, of which glaciation was perhaps the most striking manifestation. The expulsion of man from his original garden home, the use of "skins of beasts" for clothing, and the adoption of an animal diet, all seem to point to a permanent deterioration of climate. But however this may be, the account of the Fall is either a history of facts or an apologue. If the latter, it can have but one root—the necessity felt by early thinkers for some means of reconciling the vast amount of evil existing in the world with the supremacy of a wise and benevolent God.

"A Scientific Layman," without adopting the extreme creed of the Optimist School, seems to us rather to under-estimate the amount of suffering in the world. When saying "Death, if sharp, is a short event," he scarcely gives due weight to the fact that multitudes of animals perish yearly from the sheer want of food. We have not clear evidence that there is "keen pleasure in the excitement of the very strife which animals wage." Such pleasure will assuredly not be felt by the mother-bird vainly striving to defend her nestlings against rats, weasels, or snakes. It will have scant room in the frog chased by a cobra, or in the antelope seized by a tiger. We must also bear in mind that the struggle for existence, as between species, is far from leading to the survival of the most useful and the most beautiful. The species, animal or vegetable, that gain ground in the world appear to be mainly vermin and weeds.

In the chapter on God we read:—"It would certainly seem as if the Divine Architect had aimed at magnitude rather than perfection, and the good of the greatest number rather than the good of all. It would seem that His great problem was the utilisation of energy for the support of immense multitudes of successive beings in a state of partial happiness." This view differs after all but little from that which the author quotes from the "Journal of Science," viz., that if a maximum of earthly enjoyment and the minimisation of earthly suffering had been the objects of the Creator, the world would assuredly have been constituted very different from what it is.

The chapters on Prayer, Immortality, Revelation, Christ, the Old Creed, and the New Evangels, though of profound interest, lie outside of our legitimate scope.

In the conclusion the author brings forward certain wholesome cautions, too often overlooked. He reminds us that Science cannot deny the spiritual efficacy of Prayer, and cannot demonstrate that there is no Hereafter. He bids us consider that the process of Evolution is not at all fully understood, and that even the theory of the conservation of energy is only "a daring inference drawn from our present scientific experience."

The "New Truth and the Old Faith" is a work well deserving thoughtful perusal, and may be advantageously studied even by the many who will not accept the author's conclusions.

The Causes which Produce the Great Prevailing Winds and Ocean Currents, and their Effects on Climate. By C. A. M. Taber. Boston: D. Clapp and Son.

This small pamphlet deals with most important questions, and supplies matter for grave reflection. In his speculations on glaciation, the author remarks that the Antarctic ice-cap is constantly increasing in diameter, and will probably continue so to do till it closes the channel connecting the Atlantic and Pacific south of Cape Horn. Glaciers have already appeared in the Southern Andes, and with a fall of temperature will rapidly cover Patagonia and Chili, and push out to sea, uniting with the southern ice-cap.

The author criticises the theories of Lyell and of Dr. Croll, and finds himself unable to accept them. He points out that ice is gradually increasing round the Poles in both hemispheres. The northern regions are being chilled because the Arctic currents are constantly forcing the waters of the Gulf Stream southwards. All the climatic agents now operating in northern latitude furnish all the conditions requisite for the slow but constant increase of cold, and consequently for the introduction of a new Glacial epoch. In support of this view he cites facts of common notoriety. The oceans of the temperate zone have become more boisterous than in the days of the early navigators. Greenland was found by the Northmen clothed with verdure in parts now covered with enormous glaciers. Iceland has retrograded in fertility. In France the culture of the vine is admitted by Arago to be receding southwards. The past three winters in Britain have been of exceptional severity, and our summers have been now for several years most pitiful. Even the most effeminate writers in our comic and "society" papers can now scarcely

pretend to suffer from heat in July and August. In Norway the past winter is said to have been more severe than has been experienced for many years.

If such a change is really going on, agricultural depression in Britain and Ireland, with all its consequences direct and indirect, must continue to increase in spite alike of legislation and agitation. Civilisation in Europe will gradually have to retire, and those nations which have secured territories in tropical or sub-tropical regions will be compelled to take refuge there. The narrowed expanse of habitable and cultivable lands will necessitate a wolfish struggle for existence, in which the weak and the scrupulous must perish. The only fact we can remember which does not agree with the author's prediction of an approaching ice-age is the decrease of the glaciers of the Alps.

We must recommend this little work not merely to men of science, but to all who can see or who care to look beyond the exigencies of the present moment.

Sight: an Exposition of the Principles of Monocular and Binocular Vision. By Joseph Le Conte, LL.D., Professor of Geology and Natural History in the University of California. London: C. Kegan Paul and Co.

Prof. Le Conte will be doubtless favourably known to most of our readers as an able and thoughtful naturalist, but they will be perhaps some little surprised to find him taking up a subject which is generally left to the physicists. He contends, however, that there is not in the English language any work covering the same ground as that which he has selected, and he pronounces, not without truth, the study of vision almost exceptional as a means of scientific culture, connecting together, as it does, the sciences of physics, physiology, and even psychology.

In an introductory section the author treats of the relation of general sensibility to special sense. He deals with the gradation among the senses. In touch we require direct and generally solid contact; in taste, liquid contact; in smell, aëriform contact; in hearing contact is no longer needed, and we perceive at a distance; lastly, in sight, we recognise objects at a distance which is illimitable. He remarks that it is on these two higher senses that Fine Art is wholly, and Science is mainly, founded. Here we must suggest a doubt. We have often imagined it possible to constitute a fine art appealing to the sense of smell, and in chemistry both smell and taste give us much more information concerning the properties of bodies than does hearing. Prof. Le Conte confines himself, in the book before us, to human sight,

and he considers, in succession, monocular vision, binocular vision, and some disputed points in the latter.

As regards the defects of the eye now so frequently met with, he points out an error in the popular notion of presbyopy, the so-called long-sightedness of old age. Such an eye sees distant objects precisely as does the normal eye. Its focus of parallel rays is not behind, but on the retina. There has not taken place any flattening, but the power to adjust for near objects has been lost. Short-sightedness is a structural defect which does not disappear with advancing age; presbyopy is a functional disorder. The true opposite to myopy (short-sightedness) is the unusual defect of hypermetropy. Persons in this state, even when young, see near objects imperfectly; when old they fail to see either distant or remote objects with clearnesss, and require two kinds of glasses—one for near, and one for distant objects.

We find a notice of Stanley Hall's recent theory of colour-perception. He argues that colour is perceived by the cones alone, that different parts of the same cone vibrate with different degrees of rapidity, and that the conical form is adapted for this purpose. In an occasional reference to instinct we are glad to find so eminent and well-tried an observer declare it to be "inherited experience."

A peculiarity of the work before us is that the author pronounces the normal eye a master-piece of Nature, and infinitely superior to the microscope. Certain modern writers take a decidedly different view, and pronounce it not nearly so good as the objectives of our best microscopes. There is here scope for a not uninteresting discussion.

In the last chapter we find the comparative physiology of binocular vision regarded as a gift bestowed upon the highest animals only, and not impossibly connected with the development of the higher faculties of the mind.

One feature of this book strikes us as in need of explanation. Though printed in London, we find in it those peculiarities in orthography which have been adopted in the United States. The Americans have, of course, the right to spell as they please, but we surely may put in a similar claim, and must protest against having "fiber" and "center" insinuated into a bock published in England, and to be read by Englishmen.

Note-Book of an Amateur Geologist. By JOHN EDWARD LEE, F.G.S., F.S.A. London: Longmans and Co.

THIS work consists of a large assortment of plates executed from the sketches made by the author in the course of his geological and archæological rambles, and of accompanying descriptions.

Hence, though containing much valuable matter, it is a difficult subject for the critic.

Mr. Lee is one of the founders of the British Association, and was the intimate friend and companion of the late Prof. Phillips. As such he has taken no small part in the progress of geology. Hence interesting anecdotes crop up unexpectedly among the descriptive matter. It appears that he had once agreed with Prof. Phillips—then President of the Geological Society—to undertake a thorough examination of the strata underlying the chalk in Lincolnshire. "The reader may imagine my surprise when, the day after one of the meetings in London, Prof. Phillips wrote a characteristic little note, of little more than half-a-dozen lines, saying that at the meeting an unknown young man, of the name of Judd, read an excellent paper on the Lincolnshire beds, and that consequently our work was done, as he had worked it far better than we should have done it. Our excursion was given up, and the unknown young man is now Professor Judd."

In 1842-3 the author experienced a peculiar misfortune. In the former year he had forwarded to the "Annals and Magazine of Natural History" a paper on some Dermal Plates of Saurian Character from the Wealden of the Isle of Wight. A drawing accompanied the paper, and a correspondence ensued with one of the editors, who said that if the scale were sent up to his care a careful drawing of it should be made for the plate. This was done, but month after month passed over without the insertion of the paper, and it was not till some time after that the editor expressed his great regret that the paper, the drawings, and the specimen itself, had been lost in a public conveyance on the way to the lithographer! The almost unique specimen was never recovered. Fortunately a rough drawing had previously been sent to Mr. Charlesworth, a copy of which and of the paper are here inserted.

When on the Riffelberg, in Switzerland, the author made an observation which confirms the popular assertion that some local cause renders the indications of the compass incorrect.

The bulk of the work, however, as we have already intimated, is intelligible only if taken in conjunction with the illustrations.

As a frontispiece we find the skull of a "cave-bear" (*Ursus spelæus*), which the author obtained from the celebrated bone-cavern of Ojcow, near Cracow. The length of the specimen is between 20 and 21 inches.

On the Geology of Florida. By Eugene A. Smith, of the University of Alabama. (Reprinted from the "American Journal of Science.")

From this interesting memoir we extract the author's chief conclusions:—Until the end of the Eocene period this region was still submerged. During the Middle and Upper Tertiary epochs the peninsula was much broader than at present, the coast-line extending from 100 to 150 miles farther to the westward. After the Miocene period there was again an elevation of Florida, followed, during the Champlain period, by submergence. Afterwards came a re-elevation, which brought up the peninsula with approximately its present configuration.

Proceedings of the Bristol Naturalists' Society. New Series, Vol. III., Part 1. 1879. Bristol: Kerslake and Co.

We are always exceedingly happy to find our provincial scientific societies active and prosperous: the Bristol Naturalists' Society may be congratulated on its position in both respects. It is doing a fair amount of work, and its financial position is satisfactory. The principal memoirs in the number before us are—"Some new Optical Illusions," by Prof. Sylvanus P. Thompson; "Underground Temperature," by E. Wethered; the "Structure and Life-History of a Sponge," by W. G. Sollas (a very suggestive paper); Cases of Prolification in *Cyclamen Persicum*," by Adolph Leipner; the "Ethnology of the Hindoo Koosh," by Dr. J. Beddoe; a "Catalogue of the Lepidoptera of the Bristol District," by A. E. Hudd; the "Fungi of the Bristol District," by C. Bucknall; and the "Pomarine Skua," by H. Chartonnier.

Owing to the dismal character of the season (1879) the excursions of the geological and entomological sections proved failures. The botanical section was also much checked in its field-work. It is, however, making good progress with a most important task—the preparation of a Flora of the Bristol Coalfields.

It may perhaps seem captious if we, after all, declare that we are not quite content with the Society. A total of 169 members is scarcely all that can be desired in so populous, wealthy, and intelligent a city! We must hope that the future will bring improvement in this respect. We must congratulate the Society in being free from that disturbing element, a literary section.

A Monograph of the Silurian Fossils of the Girvan District in Ayrshire, with Special Reference to those contained in the "Gray Collection." By H. Alleyne Nicholson, M.D., D.Sc., &c. Fasciculus III. Edinburgh and London: W. Blackwood and Sons.

This portion of Dr. Nicholson's work is devoted to the Annelids and Echinodermata, with Supplements on the Protozoa, Cœlenterata, and Crustacea, and contains descriptions of the genera *Clathrodictyon*, *Hyalonema*. *Heliolites*, *Plasmopora*, *Propora*, *Pinacopora*, *Halysites*, and *Favosites*. The Supplements refer to the Crustacean order Trilobita, to the Thoracica (Cirripedia), and to certain Annelida. Here the author examines the so-called worm-tracks of the Girvan District, a kind of organic remains explained by some authorities as the trails of wandering Annelides, by others as tracks made by Mollusca or Crustacea, while others ascribe to them a vegetable origin.

The illustrations to the work are of a very satisfactory character.

Records of the Geological Survey of India. Vol. XIV., Part 1. 1881.

From the annual report it appears that Mr. Griesbach has attempted to correlate the rocks of Peninsular India with those of the Himalayas and of the world beyond the seas.

It is proposed to establish an office of mining records in Bengal.

M. Lydekker, in a Report on the Geology of Dardistan and Baltistan, notices the size of its glaciers in the present day. That at Biafo is probably next to the Humboldt glacier of Greenland, the largest in the world. The present lower limit of glaciation is about 10,000 feet above the sea-level. The Palma glacier is pronounced to be decidedly increasing, though at one time it may have united with that of Biafo. The author concludes that the glaciers of the Himalaya were once of vastly greater extent than at present, but that there is no evidence of a continuous ice-cap over the summits of the mountains. He considers that the glaciation of Europe and the Himalayas was contemporaneous, and that the degree of cold experienced must have been far greater than at present.

M. Lydekker likewise furnishes a valuable Report on some Siwalik Carnivora.

On the Structure and Affinities of the Genus Monticulipora *and its Subgenera, with Critical Descriptions of Illustrative Species.* By H. Alleyne Nicholson, M.D., D.Sc., F.R.S.E., F.L.S. Edinburgh and London: W. Blackwood and Sons.

Prof. Nicholson steadily continues his laborious researches in palæozoology, turning his attention mainly to marine forms of life. He disclaims for the present work the title of a monograph, as it does not even exhaust his own collection of Monticuliporoids. He complains, and with perfect right, of the difficulty of identifying many, even typical, species. When using a name we are not certain of really dealing with the form so named by the original founder of the species. Hence an immense amount of work remains to be done before palæozoology has definite materials to work upon, and the determination of stratigraphical horizons by means of their characteristic fossils is—especially as far as the palæozoic deposits are concerned—rendered very untrustworthy. Hence the object of the work is to define and characterise forms which have been insufficiently described. The illustrations have been chiefly drawn by the author himself, and, in all but three or four instances, from specimens and slides in his own collection.

Dr. Nicholson defines the genus *Monticulipora*, in its widest sense, as "including forms in which the corallum is composed of numerous closely approximated tubular corallites, the walls of which are never absolutely amalgamated with one another, though sometimes apparently so. Walls ofthe corallites imperforate; septa entirely wanting; tabulæ always present in greater or less number, though sometimes obsolete; generally 'complete,' and approximately horizontal, but sometimes incomplete. The corallites are sometimes divisible into two distinct groups, one of large and the other of small tubes, the latter usually more closely tabulate than the large tubes. The surface often shows, at regular intervals, areas raised above the general level of the surface 'monticules,' or slightly depressed, and then known as maculæ." The author then examines the modifications of this general outline as exhibited in the subdivisions of the genus. He shows that the nature and disposition of the corallites are not sufficient for a basis of natural classification.

On the development of the group he is unable to agree with the conclusions of Dr. Lindstroem. As regards the affinities and zoological position of the group, he considers that there is no real relationship at all between *Heteropora* and *Monticulipora*. He then reviews the relation of the genus to the extinct forms *Chæteles*, *Stenopora*, *Tetradium*, *Ceramopora*, and *Heterodictya*, and proceeds to a consideration of the subgenera and the species.

The book, even to naturalists who have no specific acquaintance with the group in question or its allies, presents undoubted evidence of sterling work.

Text-Book of Systematic Mineralogy. By Hilary Bauerman, F.G.S. London: Longmans and Co.

This treatise is a worthy member of Messrs. Longmans' valuable series of "Text-Books of Science," and will be of great use to those students—not too numerous—who are engaged with mineralogy as distinct from geology, on the one hand, and from chemistry on the other.

The author characterises minerals as inorganic natural species, to be distinguished from each other by considerations of form, structure, and composition. The determination of the first of these points, *i.e.*, crystallography, may be pronounced a purely geometrical question. The author points out the law, established by observation, though not explained, that all save the simpler types of symmetry about an axis, *i.e.*, the binary, the quaternary, ternary, and senary, are wanting. Pentagonal symmetry, so common in the organic world, is here wanting.

In the crystallographic part of the work Mr. Bauerman adopts a mixed system of notation, designating the forms by their symbols according to Naumann, and noting their faces by the indices of Miller's system.

We are glad to find the optical properties of crystals dealt with in a reasonably full and satisfactory manner. These characters are becoming daily of more importance in the diagnosis of mineral species,—and we may add of chemical compounds,—organic or inorganic. It is therefore very satisfactory to know that there exists an accessible work of moderate compass to which the student may be referred. The phenomena of double refraction, of uniaxial and circular and biaxial polarisation, interference figures, rhombic and oblique dispersion, are clearly described.

After due notice of the thermic and electric properties of minerals the author passes on to their chemical examination, in which he adopts the system of Rammelsberg.

Descriptive mineralogy is reserved for a future volume. The work is one which may be unhesitatingly recommended.

A Preface to, with Extracts from, a Book of the Beginnings. By Gerald Massey. London : Williams and Norgate.

We have here specimens of a work which, if the author's contentions can be maintained, is likely to effect a grave modification in anthropology, not to speak of philology, mythology, and other studies more remote from our ordinary subjects. Hence we venture to say that it deserves a calm and serious examination at the hands of competent judges. To make of such a book a mere peg upon which to hang jests far from "sage-born" is a mistake much to be regretted.

Mr. Massey holds that Inner Africa—some region to the south of Egypt—is the cradle of civilisation and of language, and not Chaldæa, India, China, or the highlands of Central Asia, He considers that the Sanscrit and Prakrit languages are comparatively modern. The "Aryan hypothesis," or, as one of his correspondents terms it, the "Indo-Germanic nuisance," he sets aside. He treats sun-worship, and consequently the solar myth, as posterior to moon-worship and star-worship. He goes farther back than the "roots" from which Prof. Max Müller and his school seek to derive language. Now we make no claims to authority as a philologian, but when weighing in the balance, and finding wanting, Prof. Müller's alleged distinction between man and the lower animals, we felt compelled to say that it would be necessary to go much farther back than he has done. The most intimate knowledge of the composition, flow, and quantity of the water of the Thames and its tributaries does not enable us to dogmatise on the vapours from which such waters have been condensed, or on the currents which have wafted them hither. When Prof. Max Müller, in his reply to Prof. Huxley's laudation of the new Birmingham College, sought—on the "nothing like leather" principle—to argue that things could not be rightly studied without a previous training in words, we, who hold that there is nothing in words beyond what their generally ignorant framers put into them, could only sigh at the illusion. We felt convinced that words would yet be thrust down to their true level as the mere "counters of wise men." It seems to us that Mr. Massey is operating in this direction. He writes—"Such supposed roots as Pâ, Tâ, and Mâ, in Sanscrit are not roots at all, *i.e.*, not primary, but reduced forms of earlier words found with their ideographic determinatives in the hieroglyphics, and with the roots vanishes the rootage." "The thing we most need to know at present is not what was the 'inward mental phase' that corresponded to the so-called 'roots' as the germs of human speech, but what are the outward and visible types by which the early men represented their thoughts to the best of their ability." "The types in which the earlier thinkers *thinged*

their thoughts are recoverable." Thing and think! The connection is suggestive.

Concerning the validity of Mr. Massey's speculations we can form no decisive opinion from the mere fragments of his work before us. The criticism which we should suggest would first and foremost involve an inquiry how far the origin of mankind and of civilisation in Africa agree with known facts and laws, geological and biological. We may provisionally declare that equatorial Africa is a very likely place for the origin of mankind, and here, accordingly, geological research should be pressed forward.

We salute Mr. Massey as a fellow Evolutionist, though knowing nothing of him save what we glean from these pages, and we trust his views will meet with that impartial scrutiny which, we are sure, is all he demands.

Bulletin of the United States Geological and Geographical Survey of the Territories. Vol. VI., No. 1. Washington: Government Printing-Office.

THIS volume contains the report of Prof. Asa Gray and Sir J. D Hooker on the Vegetation of the Rocky Mountains, in comparison with that of other parts of the world. This elaborate and celebrated document has already been widely circulated in England, and accordingly gives little scope for comment. Many readers must have been no little surprised at the richness of the Japan Manchurian forest flora, which in number of species so far exceeds that of the Atlantic American forest, not to speak of the far poorer forests of Europe and of the Pacific Slopes of North America. These features of distribution are shown to depend not on present conditions of the climates, but on their meteorological history. "Vegetable archæology," as Prof. Gray terms it, is a new and promising field for botanical research.

That able and indefatigable palæontologist Dr. E. D. Cope has furnished memoirs on certain new Batrachia and Reptilia from the Permian beds of Texas; on a Wading Bird from the Amyzon Shales; on the Nimravidæ and Canidæ of the Miocene; and on the Vertebrata of the Wind River Eocene Beds of Wyoming. The Nimravidæ are a group composed of seven, or perhaps eight, extinct genera, which the author separates from the true cats as having the carotid and condylar foramina entirely distinct from the foramen lacerum posterius, and as having, further, an alisphenoid canal and post-glenoid and post-parietal foramina, which are wanting in the Felidæ. He suggests that the Oxyœnidæ may have been the ancestors both of the Felidæ and Nimravidæ, though several intervening forms are missing

Certain of the Nimravidæ appear to have been large and formidable.

Amongst the species obtained from the Wind River Eocenes a prominent place belongs to *Protopsalis tigrinus*, belonging probably to the Oxyœnidæ. It was an animal apparently equalling the tiger in size.

A Complete Course of Problems in Practical Plane Geometry, with an Introduction to Elementary Solid Geometry. New Edition, Revised and Enlarged. By JOHN WILLIAM PALLISER. London: Simpkin and Marshall.

THE author, after pointing out the importance of geometry for art-students and artizans of every kind, tells us that in his practical experience as a teacher—in connection, more especially, with the Leeds School of Art and Science, and with the Science and Art Classes of the Leeds Young Men's Christian Association—he has been unable to meet with a text-book at once sufficiently cheap and comprehensive for his students. He found that both teachers and pupils were obliged to obtain and consult a number of works on geometry in order to prepare for the examinations of the Science and Art Department. To do away with the consequent expenditure of time and money he has issued the work before us. Now although we do not believe in examinations, and consider that preparing for these performances is a radically false starting-point in any science whatsoever, we consider that the manual before us is likely to be very useful. It is characterised by clearness, simplicity, and a sound arrangement, and will, we think, fully meet the exigencies of the case.

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

THE EARTH'S TEMPERATURE.

To the Editor of the Journal of Science.

Hypothesis: The heat of the earth is caused by pressure.

Sir,—Although not aware of it, I am probably not the first to attribute the temperature of the Earth—or rather the increasing heat thereof—to pressure, or, in other words, to maintain that the weight of the material above becomes converted into heat below,—its only escape; and, on inquiry into the matter, this theory seems amply borne out by fact: moreover, I am encouraged to lay this view before the world, because on mentioning it to an authority in these matters he did not see reason to reject it, but was not prepared to express an opinion.

It is almost certainly demonstrated that, after reaching the depth of about 50 feet below the surface, the temperature regularly increases at the rate of 1° F. for about every interval of 60 yards. Thus, if it can be proved that the pressure of a layer of rock would produce the same rate of increase, it is very plausible to infer that this is the cause: this can, I believe, be satisfactorily shown.

Dr. Joules's statistics of the conversion of mechanical energy into heat are, I think, the best to go by. He demonstrates conclusively that if a weight of 1 lb. fall 772 feet, it will raise the temperature of 1 lb. of water 1° F. His experiment, of course, cannot be applied to earth, yet the latter is a material like the former, and is under the same laws. Will not the same pressure on a pound of water produce the same amount of heat as on an equal amount of earth? Now the foot-pounds to raise a cubic foot of water 1° F. are 48·250; but directly we turn to minerals we are at once met with a host of differences in weight. Taking Molesworth's Tables we find 150 lbs. per cubic foot about a fair average. Practically a column of rock $12'' \times 1^2{}'' = 1$ lb., or a cubic foot 144 lbs. (Mr. A. Lupton, Yorkshire College), perhaps rather more. At the end of the first depth of 60 feet, for 1° F.,

we reach the depth of 330 feet (50 + 60 yards). Multiply 330 × 144 = 47,720, a figure which, all sides considered, is identical with Dr. Joules's, and from a perfectly different source.

May we not say, then, that the *actual* state of the heat of earth agrees with the theoretical hypothesis and Dr. Joules's experiments, and that *the heat is due to the pressure.* No one denies that pressure does produce heat; even so light a thing as air is found to be heated by compression with its own weight at the bottom of a pit's shaft; and air, if compressed strongly enough, will ignite tinder, as most people know,—then why not earth?

It may be argued that this would uphold the theory of the fluidity of the earth's interior, but seemingly we are as much in the dark as ever. For if we consider the earth as made up of so many concentric hollow spheres, fitting one inside another, we can see that the weight, or gravity, is really concentrated in the inner side of the globe, and, being circular every way, is self-supporting; so much so that the imaginary resultants will not pass beyond the inner surface centreward, and therefore there will be little, if any, downward thrust. It is evident, also, that there would be a greater weight, side thrusting, &c., in the outer sphere than in any of the inner ones; hence the heat would actually decrease (from this cause) towards the earth's centre: there must be a limit to compression; we cannot press material that cannot escape anywhere into nothing. Moreover, if the world were a mass of fluid in an egg-shell, would not its magnetic influence be destroyed, &c.? We must always look at these things with a large, comprehensive view; even in our deepest mine we have not even pierced this egg-shell in proportion, and therefore can draw no indisputable conclusion.

And finally, why are volcanoes always at the top of mountains? The volcanoes came to the mountains, and not the mountains to the volcanoes. This rises many interesting questions which are best left till we see whether this stands.—I am, &c.,

David Yewdall Cliff.

Ilkley, Leeds, May 10, 1881.

THE FORMATIVE POWER IN NATURE.

To the Editor of the Journal of Science.

Sir,—Had it been my intention to criticise the article on "The Formative Power in Nature" in any adverse spirit, I should have affixed my name in full to the letter in your No. for April. But my comments on Mr. Billing's article were far from being in opposition to his views, and were designed rather to supplement

and support, than to controvert his arguments. I thought, and still think, that we are both on the same side in the contest between Theistic and Atheistic Philosophy, which so sadly divides modern scientists. I have no doubt, however, that he will pardon my making a few remarks upon certain observations in his second article, touching my letter.

1. Allow me to say that I did *not* suppose that he aimed at *originality*, seeing that the subject was one that scarcely admitted of it.

2. I fully agree with his severe, but well-merited remarks upon the wild and often absurd theories propounded by some (so-called) philosophers, both ancient and modern.

3. Haeckel on Spontaneity. I am quite aware of the definition Prof. H. gives of spontaneous or equivocal generation, as well as the ordinary sense of *spontaneous*, as applied to the feelings or actions of men or animals, when not controlled or influenced by any extraneous will. But I must still maintain, that to talk of that which has yet *no existence* as exerting *will* (*sponte*), to give itself existence, is absolutely contradictory. I do not indeed imagine that anything we can say (hard or not) would weigh one feather with these self-sufficient Monists; but that is no reason why we should abstain from exposing their fallacies, to the best of our ability, for the benefit of "casual readers and half-thinking men."

4. The Ether. We apparently differ slightly as to the nature of this medium, which *must* needs be to a great extent conjectural: Mr. B. considering it (p. 82) as "a gaseous substance," from the solidification of which "solid substances" (not stratifications, as first written) have arisen; or (p. 272) the "one primordial substance from the modification and differentiation of which all other forms of matter have arisen"; while I prefer to regard it as a permanent form of matter, but one *sui generis*. Let the two notions go for what they are worth. But looking to Mr. B.'s original words and their explanation, I cannot see that I was guilty of "raising a phantom assumption." I fully agree, however, that the Ether is "a subtle something which permeates the universe, and which proceeds direct from the will of the Creator, in which all things exist."

One word as to the epithet *luminiferous* (so wofully mangled in the printing). It was doubtless conferred upon the ether, because, as its existence was first revealed by *light*, so it *brings*, or is the vehicle of, light. Paradoxical as it may appear to ordinary apprehension, neither light nor heat, as such, have an *objective* existence at all. They are only rates of vibratory motion, translated into subjective sensations in the nervous system by the correlative powers of the living mind.

Mr. Billing (p. 273) implies that I consider the ether to be the *source* of light (a term I did not use), and objects that, if it were so, the higher we get in the air "the brighter should be the aspect," while balloonists find it both darker and colder. To this

I answer, that the general light of the sky, which becomes less and less as the atmosphere becomes rarer, is the result of the reflecting properties of its molecules, whether gaseous or aqueous. And were a human eye placed beyond the atmosphere every part would appear absolutely black, except the spaces occupied by the sun and other celestial bodies, whose brightness would be almost insupportable. In the same way *sensible heat* depends much less upon the direct rays of the sun than upon the secondary vibrations set up in the denser media by which we are here surrounded: it is only in *part* due to the direct heat-rays of the sun.

To my own mind the conviction appears irresistible, that not only does the ether "proceed direct from the will of the Creator," but that all its wondrous motions are nothing else and nothing less than the constant, regular, and orderly acting of the same Will, using it as its main instrument throughout the universe. And as I seem to be challenged (p. 276) to say what I conceive *force* to be, I do not hesitate to define it as the acting of the will of a living mind (either original or created), and that all physical forces which are not the result of created minds, are necessarily the outcome on the Supreme Mind and Will.

I must not trespass further upon your space than to add, that my name, unabbreviated, will be found at the head of the first article in your *Journal* of last January.—I am, &c.,

H. B.

A FIRST CAUSE.

To the Editor of the Journal of Science.

Sir,—I submit that the following is a reply to the letter of "A Lucretian," on p. 304 of last No. of your Journal. Dr. Büchner says "a force can only exist in as far as it is active;" this is quite right. Newton says of it "*consistit in actione solâ.*" But, using "force" in its correct technical sense, it is clearly wrong to speak of the first cause of the world as a *force*. If we can give it any name derived from dynamics, we should call it an *energy*. But an energy does not depend on activity for existence. The very title of Dr. Büchner's well-known book, "Matter and Force," taken in connection with its object, is enough to show that he uses "force" (*kraft*) in a vague unscientific manner, and that he is open to the complaint made by Clifford against numerous writers on the subject of Force (*see* "Nature," June 10, 1880).—I am, &c.,

M. H. C.

SANITARY CONDITIONS.

To the Editor of the Journal of Science.

Sir,—A medical contemporary of yours remarks it as something anomalous that the Boers of the Transvaal should be hale and vigorous whilst living under very imperfect sanitary regulations. The writer seems to forget that these men are at any rate free from the most important of all causes of debility, *i.e.*. worry and over-work.

The men who first enticed women and children into an industrial career, and they who have in later times devised the scheme of competitive examination, have done more to enfeeble the British race than can be counterbalanced by the most perfect systems of drainage and ventilation, with the highest personal cleanliness superadded.—I am, &c.,

G. O. H.

AN ALLEGED CONTRAST BETWEEN MAN AND BRUTES.

To the Editor of the Journal of Science.

Sir,—In his essays on the "Unity of Nature" the Duke of Argyll seeks to point out an anomaly in the moral conduct of man as contrasted with that of the lower animals. He mentions especially three points in which man differs unfavourably from the lower animals, viz., his propensity to infanticide, to cannibalism, and to ill-usage of the weaker sex. It seems to me, however, that the distinction is by no means absolute. Among several species of rodents—*e.g.*, the rabbit—the female hides her young from the male, and has occasionally to defend them against his attacks. The same thing occurs among the Felidæ. The sow and the female cat will occasionally kill and eat their own offspring, and that not from want of food or lack of shelter. Male alligators greedily devour the young of their own species. The eagerness of the queen bee to put to death her female progeny is well known.

Cannibalism is likewise not unknown among brutes. Rats, if shut up together, fight, and the weaker ones are devoured. Wolves eat up a wounded comrade without mercy. A stronger

spider is always ready to kill and eat a weaker individual, even of the same species.

Nor is the weaker sex always treated with kindness by the stronger. The domestic cock sometimes takes a dislike to a particular hen, and in such cases he beats, and even kills her. An ill-tempered bull has been known to gore a cow. Among American deer the male has been observed tyrannising over the female. Prof. Semper relates a similar case concerning a pair of prairie-dogs which he keeps in his house. Among spiders, where the female is the stronger, the male often serves as a nuptial banquet for his spouse.

Hence there is not in this respect that absolute contrast which the noble author seems to assume.—I am, &c.,

SCRUTATOR.

NOTES.

Mr. Charles Darwin has expressed his ideas upon vivisection in a letter to Prof. Holmgren. He writes:—"I know that Physiology cannot possibly progress except by means of experiments on living animals, and I feel the deepest conviction that he who retards the progress of Physiology commits a crime against mankind. Anyone who remembers, as I can, the state of this science half a century ago must admit that it has made immense progress, and it is now progressing at an ever-increasing rate. What improvements in medical practice may be directly attributed to physiological research is a question which can be properly discussed only by those physiologists and medical practitioners who have studied the history of these subjects; but, so far as I can learn, the benefits are already very great. No one, unless he is grossly ignorant of what Science has done for mankind, can entertain any doubt of the incalculable benefits which will hereafter be derived from Physiology, not only by man, but by the lower animals."

"The vivisectionists," says Mr. E. M. Boddy, "protest with well-feigned horror at a frog or a rabbit, under the influence of chloroform being experimented upon for the benefit of humanity, whilst they see, without allowing a sign of disapprobation to escape them, an inoffensive hare chased to death for the amusement of gentility."

P. Grawitz has experimentally refuted both the current hypotheses on the protective action of vaccinations, in the generalised sense of the term. He shows that blood from rabbits which had been inoculated with Aspergillus, if mixed with a further dose of the spores, developed a luxuriant crop of fungus. Hence the blood had neither been exhausted of any pabulum, nor had any antidote been developed in it.—*Virchow's Archiv. für Path. Anatomie.*

According to papers communicated to the Bristol Naturalists' Society, by Dr. Beddoes, F.R.S., and Mr. F. F. Tuckett, the size of the human head in this country has been gradually diminishing during the last twenty-five years. The evidence on which these authors base their conclusion is obtained from hatters in various parts of England and Scotland. One hatter writes:—"Fifteen years ago the usual sizes of hats in England were from $6\frac{3}{4}$ to $7\frac{3}{8}$, and even $7\frac{1}{2}$ was not uncommon, but now if a $7\frac{3}{8}$ hat was wanted we should have to make a block purposely." *Quære*, has a similar decrease been observed in France, Germany, and the United States?

Dr. R. W. Shufeldt (" American Naturalist ") points out that comparatively few birds are free from disease or the sequelæ of disease, and gives some interesting cases from his own observation.

In the same journal A. S. Packard, jun., gives a very valuable description of the brain of the locust as compared with the same part in other insects.

The same writer agrees with Prof. Carl Vogt in holding that different continents may have simultaneously produced representatives or similar species, and that we should not accept a single centre of creation for all faunas.

A writer in the " American Naturalist " strongly insists upon the value of the wren as a destroyer of noxious insects.

Prof. S. A. Forbes, of the Illinois State Laboratory of Natural History, in the same journal, argues that a species injurious to man can never be exterminated by a parasite strictly dependent upon it.

According to the " Medical Press and Circular " an " anomalous febrile disorder " has appeared in Aberdeen in the present month. In all the cases the patients had obtained a supply of milk from one particular dairy farm in the neighbourhood. But the cows there were healthy, and the water-supply unimpeachable. The turnips given to the animals were suspected, but nothing definite has transpired. Were the cows fed on sewage-grown turnips or hay?

Edgar L. Larkin, in "Science," argues that if the gaseous matter originally filling the universe was, as supposed by many authors, a " glowing vapour " or a " fire mist," the law of the 'correlation of force' or the 'conservation of energy' must fall to ruin.

According to the same journal Dr. A. F. A. King read a paper on " Septennial Periodicity " in the Organic World, before the Biological Society of Washington. The learned author drew attention to the phenomena of menstruation, œstration in animals, gestation, contagion, epidemics, and climax of fevers.

M. de Quatrefages, in certain laudatory remarks on the " Leçons d'Anatomie et de Physiologie Comparées " of Prof. Milne-Edwards, pronounced it a work which would be for a long time for all students what Haller's great work was formerly! Those who remember how disastrous the influence of Haller proved for biological science will not regard this comparison as a high compliment.

The perch in the Seine are at present suffering from an epidemic attack of a parasite.

According to M. H. Filhol ("Comptes Rendus") the fossil remains of *Ursus spelæus* possess a great fixity of type, and show no connection with the modern *U. arctos*. A skull of the latter species, of an enormous size, has been found among about a hundred specimens of *U. spelæus* in the Cave of Lherm, in the Department of Arriège.

It appears that the writers of the Talmud held and taught the globular shape of the earth. This is the more interesting since at this moment bills are being circulated denouncing existing astronomical truths as of heathenish origin, and urging the formation of a society to advocate the flatness and fixity of the earth.

W. von Reichenau, in a recent work on the nests and eggs of birds, explains the ornamental plumage, crests, &c., of the male sex as due to an excess of vital energy, whilst the females are comparatively exhausted by the production of eggs and the task of incubation.

According to MM. Klebs and Crudeli ("Att. Dei Lincei," Sec. 3, vol. v., p. 19) the malarial parasites (*Bacilli*) pass through a series of phases corresponding to the successive stages of the disease.

According to a series of careful experiments performed by Dr. C. A. Cameron ("Analyst"), the milk of individual cows may contain less than 9 per cent of solids *minus* fat. But in mixed milk 9 per cent is a fair proportion to expect. The milk of Dublin dairy herds contains 13 to 15 per cent of solids.

The views of Mr. Larkin and Mr. Morris on the evolution of matter and of the heavenly bodies are being criticised ("Science," April 16) by Prof. Al. Winchell.

Mr. A. D. Bartlett points out a curious distinction between carnivorous and herbivorous animals. The former, if caught young and kindly treated, become much attached to their keepers. On the other hand, stags, antelopes, sheep, &c., if brought up as household pets, invariably turn out dangerous.

The Mosaic prohibition of blood as an article of diet, whatever may be its origin, is in full accord with the dictates of the most advanced science of modern times.

Mr. J. W. Norris, the Superintendent of the United States Yellowstone National Park, has issued a most interesting report on the geological and biological features of this wonderful region.

Prof. Asaph Hall ("Science") pronounces the Nebular Hypothesis a very doubtful thing, though "possibly its supporters may fudge it so that it will last a little longer."

We learn that Mr. G. Benn, of Glenravel House, Co. Antrim, has presented the valuable collection of antiquities formed by his brother, the late Mr. E. Benn, to the Belfast Museum.

S. A. Forbes, of Normal, Illinois, having shot and opened twenty-five sparrows, found that at a season when 30 per cent of the food of the robin, 20 per cent of that of the cat-bird, and 90 per cent of that of the blue bird, consisted of insects, the stomachs of the sparrows did not contain more than 6 per cent of insects.

The muster-roll of the Royal Commission on the Medical Acts will excite astonishment in foreign countries. It comprises the Earl of Camperdown, the Bishop of Peterborough, Sir G. Jessel, Mr. Sclater-Booth, Mr. W. Cohen, Prof. Bryce, Sir W. Jenner, Prof. Huxley, Mr. Simon, Prof. Turner, and Dr. R. McDonnel. Only four medical men !

Dr. Dowse, in his work "The Brain and Diseases of the Nervous System," says "Brain exhaustion from over-study and so-called cramming is perhaps one of the greatest social evils of modern times, and is simply a blot upon advancing civilisation.'

According to M. Voitellier, rabies in dogs is more common in the male sex than in the female, in the proportion of 100 to 14.

A Microscopical Society is about to be established at Carlisle.

The "Monthly Magazine of Pharmacy," in reviewing Prof. St. George Mivart's recent work "The Cat," remarks—"However much we may differ from him (the author) in his Darwinian proclivities, and certain other of his philosophical opinions," &c. We should think anyone reading Mr. Mivart's "Lessons from Nature" would pronounce his proclivities decidedly anti-Darwinian.

M. Turpin has laid before the French Academy of Medicine a series of 1440 pigments, suitable for children's toys, and all of them free from poisonous matter.

According to the "American Journal of Microscopy," red blood corpuscules were detected in eleven out of twenty specimens of vaccine lymph.

We were misinformed when we stated that Dr. Beale's late Presidential Address would not be printed. It appears in full in the "Journal of the Royal Microscopical Society."

H. H. Howarth, in his paper on the Mammoth in Europe ("Geological Magazine"), points out that the terms Europe and Asia are purely artificial, and correspond to nothing in physical geography. Between the two there is no botanical or zoological barrier.

Mr. W. G. Lock ("Geological Magazine") suggests the possibility of a mass of molten matter underlying Europe, and connected with the Icelandic volcanic vents.

A sea-side biological laboratory will be opened at Annisquam, Mass., on June 5th, under the auspices of the Boston Society of Natural History and the Woman's Education Association.

"Science" considers that the immunity from a second attack of an infectious disease, such as poultry-cholera, is simply inexplicable on the parasitic theory.

The "American Naturalist" suggests a joint meeting of the British and the American Associations for the Advancement of Science, to be held in 1883. The idea seems to us excellent, but we fear it will meet with much passive, if not active, opposition.

It appears that during the severe weather of January rooks were found killing and eating sparrows, and even the blackbirds began to prey upon each other.

According to Grawitz ("American Naturalist") the mould Eurotium and Aspergillus possess forms which produce death within a few days if they penetrate into the circulatory system of animals.

"Blackwood's Magazine" points out that the revival of suicide coincides in time with the modern spread of education, and is most rampant where the schoolmaster is most active.

A young Russian lady, who was studying Medicine in Paris, shot herself in despair of passing her examination.

A case of fasting is in progress in Strathaven. A girl there has for eighteen weeks taken nothing but water, and occasionally sweets.

A curious friendship between two young cats and a cockatoo has come under our notice. The cats, after having completed their own toilet, generally wash the bird in the most approved manner.

Dr. Alleyne Nicholson will conduct the Natural History Class at Edinburgh University, in consequence of the indisposition of Prof. Sir Wyville Thompson.

The "Medical Press and Circular," of May 11th, admits, in a leading article, the impotence of "sanitary reform" to deal with epidemics.

At the Saratoga meeting of the American Pharmaceutical Association it was shown, in the Presidential Address, that among the evil consequences of a reckless devastation of the forests, the extirpation of certain valuable medicinal plants must not be forgotten.

A zoological "station" is being commenced in the Department of the Eastern Pyrenees, and will be opened next winter.

According to a communication made to the Academy of Sciences, M. J. Chatin has detected Trichinæ encysted in the intestinal coats of the pig, as used for sausage-skins.

Messrs. L. Reeve and Co. are about to publish a complete illustrated work, by Dr. H. C. Lang, F.L.S., on the Diurnal Lepidoptera of Europe.

Dr. Seubert has determined the atomic weight of platinum as 194·46124, instead of the formerly admitted value 197·4. This change brings platinum into harmony with the requirements of the periodic law.

It is rumoured that a process for melting and forging iridium has been exhibited before the Scientific Society of Cincinnati. A bar of this metal, used in place of the negative carbon in an electric lamp, showed no loss of weight after burning for sixty hours.

The subject of colour-blindness as a possible cause of disasters at sea and on railways is attracting increasing attention.

C. W. C. Fuchs, in the "Naturforscher," gives a general summary of earthquakes and volcanic outbreaks for the year 1880. They appear to have been exceptional both in number and violence.

According to the "Baptist Family Magazine" (American) J. A. Parker's formula for the ratio of the diameter of a circle to the circumference is identical with the one "used by the architect of the Great Pyramid in its construction, and also by Moses and Solomon in the construction of the Tabernacle and Temple and their contents."

Prof. J. Collett, the State Geologist of Indiana ("Clinton Herald"), contends that the mastodon must have survived down to very recent times.

Prof. H. J. Detmers ("Science") traces the disease known as "swine-cholera" to a microscopic schizophyte, which is absent in healthy animals. The author points out a method of protecting swine against the disease by a species of vaccination.

Mr. C. H. Barton ("Victorian Review") summing up the disastrous phenomena, meteorological and otherwise, of the year 1880, which he terms "Annus mirabilis," draws the soothing conclusion that the earth is yet "instinct with vital energy," and betrays an exuberance of cosmic power not easily reconcilable with planetary old age. It might, however, be contended that the bulk of the disasters enumerated, being due to the want of heat, are by no means a proof of exuberant energy, but rather of

the decline of that which in the world corresponds to vitality in the individual organism.

Microscopic Notes.—The influence of the diffraction spectra in the formation of the microscopic image has a far greater bearing on the subject of errors of interpretation than might be supposed by the mere casual observer. If a diatom, such as *Pleurosigma angulatum*, is viewed with an objective sufficient to resolve it, and the eye-piece removed, upon looking down the tube a minute spot of light—a reduced image of the lamp-flame—occupies the centre of the field, and around it, at the extreme margin, six equidistant bright specks: these are the diffraction spectra of the object in question, which is acting like a ruled grating. If a central stop be placed in the diaphragm of the objective so as to cut off the dioptric beam, the diatom will appear with its markings resolved, but on a black ground; but if the diffraction spectra be intercepted by means of a marginal stop, the diatom will be seen on a light ground, but its markings will no longer be visible. By using a slit so arranged radially as to include one of the diffraction spectra, the dioptric beam-lines will appear at right angles to the radius; and by rotating the stop so as in turn to include different spectra, the direction of lines may be changed at pleasure. This is one of the results of the investigations of Prof. Abbe, of Jena, and the whole question of the "Function of Aperture in the production of Microscopic Images" will be exhaustively dealt with in a paper in preparation for the Royal Microscopical Society. It would seem probable that every transparent tissue may, to a greater or less extent, act on the illuminating pencil as a diffraction grating, and consequently produce spectral images: what their influence may be upon the image formed in the microscope can only be ascertained by a careful study of their action. Experiments with ruled lines have shown that, by using some of the spectra and excluding others, appearances totally false may be obtained at will, even the actual known direction and the number and distance of ruling of the lines being changed. These facts throw very great doubt upon the truth of all high-power observations, and it seems probable that a careful examination of the diffraction spectra of various tissues, with observations of the manner in which the appearance of minute structural details undergoes change, will be necessary, as a means towards the elimination of errors of interpretation, which the results of the researches of Prof. Abbe can leave no doubt exist in the whole of our past high-power observations by means of transmitted light.

The number of the "Journal of the Royal Microscopical Society" for April contains two important papers on the "Aperture" question: one by Prof. Abbe, of Jena, on "The Estimation of Aperture" (a profitable abstract would be almost impossible, but the paper deserves careful study by those who

would make themselves acquainted with the most recent discoveries in microscopical optics. The other paper is by one of the Secretaries of the Royal Microscopical Society, and is entitled "Notes on Aperture, Microscopical Vision, and the Value of Wide-angled Immersion Objectives." Mr. Crisp's object is to collect the scattered matter on the subject, some of which is printed, but the greater part exists in letters written by Prof. Abbe to Mr. Crisp and others. Pending the publication of an exhaustive treatise now preparing, these notes are of great value, especially as most erroneous opinions respecting both the aperture question and the whole theory of microscopical vision are widely disseminated; and it is to be hoped that Mr. Crisp's notes may be reprinted in a form accessible to those who do not see the Society's Journal. The paper occupies between forty and fifty pages, and, like Prof. Abbe's, could not be abridged. A number of important experiments with the diffraction spectra are described, and the microscopist would do well to repeat and carefully study them, as their bearing as to what is really seen through the microscope suggests the gravest doubts whether certain objects, such as the markings of diatoms, have been seen at all. The results of tampering with these diffraction spectra by stopping out some and using others, are remarkable, even to the total change in the appearance of an object the nature of which is perfectly known, *e.g.*, a series of ruled lines. Both their direction and their apparent number are capable of being changed, according to the diffraction spectra allowed to take part in the formation of their image.

ERRATA.

Page 273, line 23, *for* "suppositious" *read* "supposititious."

Page 303, line 3 from top, *for* "personal ties" *read* "personalities"; line 13, *for* "Reichert and Goethe" *read* "Reichert and Goette."

NOTICE.

Several important books, awaiting notice, stand over from want of space.

Mr. J. Hepburn Davidson's article on "Sham Employers" is delayed owing to the illness of the author, but will appear in our July issue.

☞ *All communications respecting the Advertisement Department to be addressed to* Mr. THOMAS BLYTON, *at the Office*, 3, *Horse Shoe Court, Ludgate Hill, London, E.C.*

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THE

JOURNAL OF SCIENCE.

JULY, 1881.

THE SOURCE OF ELECTRIC ENERGY.

By Charles Morris.

THE molecules of matter are affected in two distinct modes by centrifugal motion. In the one case this motion is, to a considerable extent, persistent in the affected molecule. Its excess vigour is but slowly yielded to other molecules, through the influence of impact or of attractive connection. This mode of motion is called heat. In the other case the molecules vigorously transmit their excess motion, yielding it with excessive rapidity to other molecules. To this phase of motion we give two names. In one form of its manifestation we designate it as radiant energy. In another form we give it the name of electricity. Whether or not, however, we should speak of these as one mode of motion, or as two distinct modes, is a question which yet remains unanswered, and is, to a partial extent, the question which it is proposed to consider in this paper.

Between heat and radiant energy there are intimate relations. They interchange with the utmost readiness under proper conditions. The same may be said in respect to heat and electricity. They, also, have close affinities, and interchange with facility. Any enquiry, then, into the relations between these three modes of motion involves an answer to the following question—Why, under one set of conditions, does the molecule of matter vigorously retain its motion; and why, under another set, or two other sets, of conditions, does it vigorously transfer its motion? And what are the characteristics of these two or three distinct sets of conditions?

In regard to heat and to radiant energy, science gives definite answers to these questions. Heat it declares to be a persistent motion of molecules, either independent of special control, as in the gas, or controlled by attraction, as in the solid and liquid. Radiance it declares to be a rapidly transmitted vibration of molecules or of etherial particles, through whose agency motive energy is directly transferred across wide intervals of space. This explanation, however, is questioned; and the latest theory, that of Clerk Maxwell, declares that there is no direct transfer of energy, but that it is, in some manner, indirectly transferred. In regard to electricity, the question yet remains unanswered. Is it a directly or an indirectly transmitted energy? Is it a rapidly transferred vibration, as in the first explanation of radiant energy? Or is it a result of some distinct and peculiar mode of motion? These are questions which still lack a solution.

As to the conditions under which radiant energy is transformed into heat, we are not without a satisfactory conception. When a beam of light or radiant heat, consisting of vibrations of greatly varied rapidity, falls upon the surface of a body, a certain portion of this energy is retained by the body, and the remainder either transmitted or reflected. The retained energy becomes heat, and little doubt is entertained as to the principle of its conversion into heat. The particles of the body acted on are at a certain tension, dependent upon their weight, their attractive connections, and the pressure to which they are subjected. Their heat vibrations, therefore, take place at a certain fixed pitch, on the same principle that a stretched string vibrates at a pitch in strict accordance with its tension. When the rays of light impinge upon these molecules every vibration which is in harmony with the pitch of molecular vibration is retained, and becomes heat. Every vibration in discord with that of the molecules is rejected. The principle is precisely the same as that of a string stretched to sound a certain note, near which a second string is made to vibrate. If the note of the second string accords with that of the first, this latter will take up the vibration. If it be discordant, the first string will remain unaffected.

If, now, we come to consider the conditions under which heat becomes electricity, we find indications of a similarity to those just considered. Every substance has its normal pitch of molecular vibration, which differs, however, with every difference in the tension of the molecules. If two homogeneous surfaces be brought into contact heat is regularly conducted from one to the other. And if a substance

be homogeneous throughout its interior, heat is regularly conducted through it. But if the two surfaces be heterogeneous, or if the one substance be heterogeneous internally, a marked difference results. Part of the heat is converted into electricity. Instead of the energy passing from molecule to molecule in the gradual and continuous heat method, part of it passes in the rapid and instantaneous electric method.

Very slight changes yield this result, and these changes are probably all changes in tension. If a wire be twisted or stretched, the heat that flows over this tense part becomes partly converted into electricity. Of if it be homogeneous, and one part of it be intensely heated, electricity likewise appears. Yet in this latter case there is also a change in tension, for the heat causes expansion of the wire, and consequently increased atmospheric pressure, which must affect the tension of the molecules. In the contact of diverse substances, or of similar substances in different states, there undoubtedly exist differences of molecular tension, and, therefore, of vibratory pitch.

If, instead of heat being conducted from one substance to another, two substances be rubbed together, similar results appear. If they are homogeneous it partly or entirely becomes electricity. And if the energy emitted be that produced by chemical action between diverse substances, a like result appears. Electricity is produced. In short, in every case in which two homogeneous surfaces receive excess motive energy, this energy flows from one to the other as heat. In every case where two heterogeneous surfaces receive excess motive energy, this energy, partly or completely, flows from one to the other as electricity. But all this electricity is eventually converted into heat, or into some condition in correlation with heat. Its existence as electricity is usually but temporary.

And the necessary condition for the temporary conversion of heat energy, or of chemical or mechanical energy, into electricity, appears to be diversity of tension in the molecules of contiguous surfaces. The same diversity exists between the molecules of heated solids and those of the gas or ether in contact with them. There is thus an analogy of condition between the production of light and of electricity. Whether this is significant of a resemblance in character remains to be proved.

Why does this difference in the relations of the two surfaces produce such a difference in results? To this important question it may be possible to give a probable

answer. In homogeneous bodies the tension of the molecules is similar, and their heat vibrations are, therefore, synchronous. The particles swing in exact unison between the attractions to which their vibration is due. They do not come into contact with each other, nor do they in any way disturb each other's condition of aggregation. They yield motive energy to one another only by the slow pull of attractive force. In homogeneous gases, however, the attraction is not sufficient to produce vibration. The molecules, therefore, move independently, and come into incessant contact. But, for reasons to be yet given, they do not disturb each other's condition of aggregation. The chief result of their impact upon each other is the equalisation of motive energy.

In heterogeneous bodies this synchronism of vibration does not exist. There is a certain degree of discordance between the motions of adjacent molecules. As a consequence they come into contact with each other. But there is another consequence of heterogeneity which is far more important; a disturbance of the conditions of motion and of aggregation, which the molecules of each surface produce in those of the other. This disturbance we know by the name of electric induction. It is the most significant feature of electric action, and possibly contains among its phenomena the solution of the mystery of electric transmission. Before considering it, however, there are other essential features of the transfer of energy to be taken into account. Among these are some special points of analogy between the phenomena of light and radiant heat and those of electricity.

If we examine closely the action of radiant vibrations on solid and liquid substances, we find other effects than those already mentioned of partial absorption and conversion into heat. There are special resistances, which differ in degree in different substances. The energy of motion concerned in radiant vibrations cannot cease to exist. It must force itself upon molecules as heat vibration, force itself through masses as radiant energy, return through the air as radiant energy, or be converted into some other mode of motion, such as chemism or mass motion. And to every one of these changes in condition there is a resistance, the result being in exact accordance with the balance of resistances. If there be sufficient accord between the radiant vibration and the molecular heat vibration, the radiant energy will be absorbed as heat. If they be discordant there is a vigorous resistance to absorption, and the energy continues radiant. Two other ordinary resistances remain, the one a resistance to trans-

mission of radiance through the substance concerned, the other a resistance to a return of the ray through the air. If the former resistance be the least the ray will be transmitted, and we call the substance a transparent. If the latter be the least the ray will be reflected, and we call the substance an opaque.

But this power of resistance has its peculiarities. Some substances resist all radiant vibrations, and are completely opaque. Others resist one range and are permeable to another. Some, for instance, permit the light rays to pass, and are opaque to the lower heat rays. Others, as rock salt, are highly transparent to these lower heat rays. Some again, among the opaques, are permeable to a slight degree, as gold for instance. Thus, whether a radiant beam, or any portion of it, shall be repelled through the air, or shall pass through the body upon whose surface it falls, depends upon the relative degree of resistance to transmission or reflection. Perhaps where resistance to both transmission and reflection is great the resistance to absorption may be more fully overcome, and vibrations only slightly in accord with the heat vibrations be received as heat. It seems, indeed, as if it might be but a question of relative resistances, these resistances being of three or more separate kinds, and the motive energy being divided up among them according to the special vigour of each resistance to each component of the ray.

These considerations in regard to light are not without their bearing upon the question of electric energy. For although many substances are completely opaque to the whole range of etherial vibrations, it does not follow that they must be opaque to all possible vibrations. The vibrations which constitute light and radiant heat occupy but a limited portion of the whole range of possible vibratory pitch. Between the lowest heat ray and the highest vibration of sound there is a vast void, capable of containing vibrations immensely varying in pitch. The whole range between several thousands and several millions of millions of vibrations per second is apparently unoccupied, and into this wide space it would not be safe to conclude that no phenomena of motion can enter. It may, indeed, be possible that every substance is transparent to vibratory waves of a certain limited range of pitch, and opaque to all above and below this range. The range of vibrations to which ether is transparent is really limited, so far as indications go. Of course, it is possible that the light and heat

rays we receive are transmitted by the air, not by the ether; and that, therefore, we know only the range of atmospheric transparency. There may be etherial rays which are reflected at the surface of our atmosphere, and which fail to penetrate to us. As for solid and liquid substances, some are transparent to this whole range, some to a portion of it only, and some opaque to the whole. But these latter may be transparent to some other range of vibrations, possibly of lower pitch than those of light and radiant heat. The highly opaque metals, for instance, may be transparent to a range of vibrations to which air and the other transparents to light are completely opaque. And it is not impossible that such a range of vibrations constitutes electric energy, for it is a well known fact that all good electric conductors are highly opaque to etherial radiation, and that the most of transparent solids are good insolators of electricity. Some transparent liquids, however, conduct electricity imperfectly; but this would only show a wide range of transparency in these liquids.

There is another fact, of some importance in this connection, which it will be well to mention before proceeding. This is the fact that all the best transparents to light are colourless. There are but few transparents which possess colour, and the transparency of these is imperfect. Opaque substances, on the contrary, are usually of strongly declared colour. Some of them reflect all the light rays, and are white in hue. Others absorb a portion of the rays, and are of some special shade of colour. Others, again, absorb all the rays, and are black. Are there not some peculiar relations revealed in this diversity of behaviour to light? Two sets of substances resist absorption of light, the colourless and the white. Of these the first set is transparent. It conducts light. The other set is opaque. It resists light in every sense, and repels it through the air. Of coloured substances some absorb more, some less, of the light rays; some reflect the unabsorbed portion, others partly transmit it. And, finally, the transmission of light through the best transparents is only partial. In all of them it is partly converted into heat.

These facts are singularly paralleled by certain facts in electrical behaviour. To electricity, as to light, certain substances are transparent, others opaque. But the best transparents, or conductors, absorb a portion of the electric current and convert it into heat. Poor conductors absorb a considerable portion of the current. They resemble the coloured transparents to light, or translucent substances.

Non-conductors resemble opaques to light. Some of them absorb a portion of the electric energy, others refuse it altogether. They are white to the electric ray. The opaque absorbents of electricity, however, have their direct analogy in phosphorescent substances. For the electricity which penetrates them does not become heat, but is subsequently emitted as electricity; precisely as the light which penetrates phosphorescents does not become heat, but is subsequently emitted as light.

Electricity and light hold to each other the following relations:—Transparents to light are, as a rule, opaque to electricity. Transparents to electricity are opaque to light. Electric rays within a solid can no more escape from it into the opaque air than light rays can escape from the air into an opaque solid. The electric rays may seem to differ from the light rays in that the former can be retained for a long time within a limited space, while light rays, when repelled, instantly disappear. But so do electric rays when they have the same opportunity. Light has an unlimited expanse of transparent matter into which to disperse. Electricity would disperse with equal rapidity and completeness within an unlimited sphere of metal, for its rapidity of transmission is closely similar to that of light. The marked differences which we discover between these two modes of energy may entirely arise from the differences of condition under which we observe them.

We may conceive of light under circumstances similar to those under which we usually observe electricity. For if we imagine a beam of light to enter a space surrounded by opaque surfaces, and closed so that the light cannot escape, we would have a case closely resembling that of a charged conductor surrounded by an insulating medium. Just how light would behave under such circumstances it is not easy to decide. We know, as will be shown further on, that it could not dart continually from side to side of the space. It might exist as a surface energy like electricity. It might slowly force itself into the surrounding surfaces, as electricity will force itself into insulating glass. Only this we can positively declare, that if a slight opening to the outer air were made any active light rays would instantly dart through this transparent channel and escape from their confinement. But we also know that, in the case of a charged electric conductor, if a slight opening be made through the opaque air, by bringing the extremity of a wire into contact with the conductor, the electric rays will instantly dart out by this conducting channel, and rush over the wire with the speed

of light. And if the wire be led to earth, the electricity will disperse as completely as the light would in the former case.

There are electrical phenomena which we cannot discover in light, and light phenomena which we cannot discover in electricity. But they each exist under conditions in which it is impossible to place the other. In short, as under the form of light we are enabled to discover many of the phenomena of radiant energy and of its relations to substance, so under the form of electricity we are enabled to discover others of these phenomena. To gain a full conception of radiant energy, the phenomena of etherial radiance and electricity must be considered in common, and dealt with as the various phases of one general mode of motion.

The most marked of these peculiar electrical phenomena are those of induction. Whether or not light rays have any analogous characters it is impossible to decide experimentally, since light cannot be placed under the conditions necessary to induction. We cannot charge a transparent with light, and examine its behaviour under such conditions, as we can charge a conductor with electricity and examine its behaviour. In the investigation of radiant phenomena, then, electricity affords us peculiar facilities in one portion of the field, as light and radiant heat affords us peculiar facilities in another portion of the field.

And in connection with electric induction, there is another special feature of electric energy which is full of significance. This is the fact of its existence in two opposite and mutually repressive states, its positive and negative conditions. By induction, we simply mean a separation of the energy of molecules into these two electric states. It is produced under the influence of electric energy in some conductor, and consists in a disturbance of the molecular energies in neighbouring matter, and a separation of these energies into two opposite states, known as the positive and negative electric states. And this separation is accompanied by what seems a repulsion of the electric state resembling that in the charged conductor, and an attraction of the opposite state of electric energy. This influence extends in all directions, internally as well as externally. To it is due the confinement of electricity to the surface of the conductor, as will be shown further on.

The influence of inductive energy appears to be almost or quite as universal as that of gravity. It extends indefinitely outward from the electrically excited body, and affects all materials, of whatever character, though not with equal

energy. There is, in fact, a resistance to inductive action, which varies in different substances; and it is, therefore, probable that the most vigorous inductive influence must soon be rendered null in a di-electric medium, though it seems capable of producing effects at very great distances in conducting material.

Inductive action seems to be, in its primary character, a strictly molecular influence, its tendency being to disturb the motive conditions of molecules. If the substance affected be a non-conductor of electricity, this is the limit of the inductive effect. But if it be a conductor, this first effect is followed by a second, the electric disturbance ceases to be confined to the molecules as individuals, and affects the mass as a whole. When, for instance, a charged conductor is surrounded by an insulating medium, its inductive effect upon this medium is certainly not of the mass as a whole, and therefore must be of the molecules as individuals. Its character is, probably, a disturbance of motive conditions, and its result is the appearance of positive electricity at one end, pole, or atom of the molecule, and of negative at the other. In the case of a conductor we have but to substitute the word mass for molecule, and the same description applies.

The mode of inductive action may be a separation of the normal or heat movement of the molecule into two dissimilar components, one above and one below the normal vibratory pitch, which respectively occupy or affect the poles of the molecule, or the two atoms, or two sets of atoms, of which it is made up. If we view the molecule as composed of two atoms, or two molecular constituents, one of these may be forced to vibrate at a rate above that normal to the molecule, and the other at a rate below the normal, they being thus respectively in positive and negative electric states. Such a discordance in motive relations set up between the atomic components of a molecule would presumably tend to weaken their cohesion, and to render the molecule susceptible to chemical change. In the case of electrolytic phenomena, we have such a susceptibility as a strongly declared feature of inductive action.

Before pursuing this line of thought further, however, it may be well to briefly consider certain probable conditions of molecular organisation. We may, in fact, look upon a molecule as a minute mass composed of atoms, in the same manner as a mass is composed of molecules. And very probably the same motive relations exist between the molecule and its atomic components as between the mass and its

molecular components. In the latter case there is a frequent interchange. Now the motion of the mass as a whole ceases, and is taken up by its molecules, to become heat vibration. Now the heat vibrations respond simultaneously to some exterior force, and thus become partly converted into mass motion. In like manner the motion of the molecule as a whole may be hindered by some exterior force, and become a motion of its atomic components. And, again, the motions of these components may be made to act in concert through some exterior force, and thus yield molecular motion. The forces producing these changes are the same in both cases. They are either impact or are attraction and repulsion exerted by distant masses. And the conditions may be the same. A pendulum vibrating at its normal pitch, if affected by a motive influence discordant to this vibration, could not respond to it as a mass. The effect, therefore, must be produced upon its molecules, which would gain new motive energy. In like manner, a molecule, affected by molecular motive influences in discord with its pitch of vibration, might refuse to respond, the atoms responding instead, with the production of what we may term an intra-molecular heat. If these molecular influences are attractive, they resemble the action of gravity on masses; if they are energies of impact, they resemble the action of collision between masses in motion.

Electrical induction is such a molecular influence, proceeding from molecules whose rate of vibration is discordant to that of the molecules upon which they act. The consequence seems to be a production of atomic energy. This energy does not necessarily come from the acting molecules, but may be a partial transformation of the vibratory energy of the affected molecules. Their freedom of movement may be curtailed by exterior resistance, and part of their motive energy fall back into their substance and become atomic energy. It is a case similar to that in which a body is thrown upward against gravity, when its rapidly diminishing mass motion falls back into its substance, and becomes a rapidly increasing molecular vibration. Or it resembles the case of a pendulum which comes to rest at one extremity of its swing, its motion as a mass having become converted into motion of its molecules as independent particles, to be re-converted into mass motion in its return swing. It is very probable that changing conditions of motion similar to this last are of constant occurrence in molecular action; and in the case of electrical influence, there may be a force exerted upon the molecule restrictive of its mass motion, which thus

becomes partly converted into atom motion or intra-molecular heat force.

It becomes advisable here to more fully consider the relations between the molecules of heterogeneous surfaces. Their influence upon each other is, very probably, a strong effort to produce homogeneity. Two molecules vibrating in contact, or in close contiguity, seek to force each other into accordant vibratory conditions. Each affects the tension of the other by changing each other's attractive relations. Yet in each there is a resistance to this effort to produce conformity, and this resistance is strengthened by the action of the more distant molecules of its own kind. There is thus a marked distinction between the action of homogeneous and of heterogeneous surfaces upon each other. In homogeneous surfaces the molecules all vibrate in strict accordance, and the only effect of the passage of motive energy from one to the other is an increased width of vibration, constituting heat conduction. In heterogeneous surfaces, the molecules of the two surfaces vibrate discordantly. Each seeks to force the other into harmony with itself, and each resists this effort. There results a disturbance of motive conditions in each, the degree of disturbance being controlled by the degree of resistance. This disturbance, however, does not seem to be a forcing of each molecule as a whole to vibrate at a new rate, but it appears to be a separation of the normal vibration into two components, one at a higher and the other at a lower vibratory pitch than the normal, and a localisation of these separate vibrations upon the two poles of the molecule. And, further, the low pitch vibration of one molecule occupies the pole contiguous to that occupied by the high pitch vibration of the other. Such we conceive to be the essential character of the force disturbance known as electric induction. Each disturbed molecule similarly affects all contiguous molecules of its own kind, so that the inductive effect runs back indefinitely through both substances.

In a non-conducting substance this is the extent to which inductive action proceeds. The disturbance is molecular only, and does not extend to the mass. But in conducting bodies the action is exerted upon the mass. Molecular energy is first disturbed, and the poles of the molecules become respectively positive and negative. But this is followed by electric conduction from molecule to molecule, which consists in a neutralisation of the electric disturbance on the adjacent poles of each two contiguous molecules. These possibly vibrate together, and their opposite electric

energies combine, and produce the intermediate heat vibration. Thus the only unsatisfied electric disturbance is that of the outward poles of the surface molecules. And this electric vibration probably flows back over these molecules, which thus become the electrified poles of the mass. A conductor thus differs from a non-conductor in the fact that in the latter case the molecules are independently electrified, in the former the whole mass acts as a single electrified molecule, the electricity being confined to its surface, and it being neutral internally.

Physical science is, in a much larger sense than is usually supposed, a science of molecules, and scientists have made many serious errors through confining their attention to masses and being oblivious to the fact that every action displayed by masses simply results from a partial restriction of the directions of molecular movements. Molecules are, very largely, independent of any common control. So far as electrisation goes, the molecules of non-conductors are thus independent, each acting as a separate mass. But in conductors they mutually restrain each other, and the electrisation becomes confined to the exterior molecules, which cannot discharge their force inwardly on account of this mutual restraint, nor outwardly on account of the resistance to conduction in the surrounding medium.

If, now, it be asked what is the underlying cause of the peculiar characteristics of induction, we cannot hope to give more than a conjectural answer. Why, for instance, does positive electric force repel positive induced force and attract negative, so that there is a distinct separation and special arrangement of these energies in the induced body? In fact, however, but three results could possibly arise from the approach of an electrified to a neutral body. In the first conceivable case, the body must remain unaffected, its molecular forces being undisturbed. In the second, the electrified body might attract similar electricity, or produce a like electric polarisation to its own on the adjacent surface of the second body. This result would affect all the molecules, two adjacent negative and two adjacent positive poles succeeding each other alternately, for the molecules must act upon each other on the same principle as masses affect each other. Such a state of affairs would absolutely hinder any conduction of electricity. There could be no electric neutralisation from molecule to molecule, while there would be a tendency to neutralisation of the opposite energies in the same molecule; and thus conduction, and perhaps production, would be forcibly prevented.

A third possible relation of the electric energies remains, that really existing. And its existence may be a result of a vigorous reactive influence in the motive force of matter. If there be a tendency to reversal of disturbed conditions, which amounts to an active energy, then we can conceive of the possibility of a forcible production of conditions like those which really arise. A molecule has a normal condition of motive energy. This is disturbed or divided into two separate conditions, to which we give the names of positive and negative electricity. But this disturbance takes place in opposition to a resisting energy, or a strong tendency in the molecule to retain or to resume its normal condition. The positive and negative energies on the poles of the same molecule tend to flow together and re-combine into the normal energy. But they also exert a like force exteriorly. Thus the positive seeks to satisfy itself from the possible negative of the adjacent molecule, and in doing so it exerts a disturbing force on the energies of this second molecule, causing a similar division of its normal motion into two components, of which the negative component occupies the adjoining pole, while the positive component is similarly related to the negative of a third molecule. So the negative pole of the first molecule exerts a similar decomposing effect upon the energies of adjacent molecules. The constant tendency is to neutralisation of these disturbed conditions, and this result may take place either inwardly or outwardly. If neutralisation takes place inwardly the molecules simply resume their normal condition, and no evident change occurs. If it takes place outwardly, between the oppositely charged contiguous poles of adjacent molecules, a positive transfer of motive force results, and it is this transfer of force which we know as electric conduction.

Inductive action acts inwardly upon the interior molecules of the charged conductor as well as outwardly upon surrounding matter. Each molecule, in fact, acts as an independent body, and affects those with which it is immediately as well as those with which it is remotely connected. Thus in the charged conductor every molecule acts inductively upon all the remaining molecules. There is, consequently, an equal inductive effect in opposite directions upon all the interior molecules. The disturbance of their energies produced by the charge in one direction must be balanced by an equal disturbance produced by the charge in the opposite direction. From this balance of opposite energies neutrality must arise.

Thus the interior of the charged conductor is electrically

neutral, and all the charge is confined to the surface. The portion of the charge on any one surface by its inductive action tends to disturb the energies of all interior molecules, and to produce an induced charge upon the opposite surface. But the portion of the charge on this surface exerts an equal influence in the opposite direction. Thus the internal molecules, not being able to respond simultaneously to two exactly opposite and equal influences, remain unaffected, and all the electric charge is confined to the surface. The force which confines it there is not really a mutual repulsion of the surface charge, but practically it produces the effect of such a repulsion.

The case of the approach of two similarly charged conductors is essentially the same as the above. If brought into contact they act precisely like a single body, opposed inductive energies affect the molecules in contact, and their charge is transferred to the remaining surfaces. But, as there is in this case a decrease in the extent of available surface, the vigour of charge on each portion of the surface is increased. Possibly the abnormal vibrations swing through a wider space in consequence of this crowding of their energy into a more contracted region. If the charged conductors be slightly separated, the effect is simply to introduce an element of resistance into the problem. The inductive effects on the adjacent surface of each of the bodies differ in degree, since in the one direction it is induction through the conductor only, in the other it acts through the conductor and the dielectric medium. This difference in inductive vigour results in a return of a portion of the charge to these adjacent surfaces, and this increases rapidly as the bodies are further separated and the dielectric resistance increased. No matter how closely two such bodies may be brought together, there is still a slight resistance, and thus a remnant of charge. And even in the interior of the best conductor a slight resistance exists. Therefore the inductive effects cannot be exactly balanced, even within the interior of a good conductor, except at its central portion. For near one surface the induction from that surface is at its strongest, that from the opposite surface at its weakest, since the latter has felt the resistance of all the molecules of the mass. Thus there is a slight difference in effect, and the surface charge may slightly penetrate into the interior. In good conductors, however, this effect is perhaps inappreciably small.

The same principles apply to the contiguity of two oppositely charged conductors. Each acts upon the other as if

upon an uncharged body. In each positive electricity is induced upon one surface, negative upon the opposite. This induced energy, being added to the pre-existing charge, results in a reduction of this charge upon one surface, and its augmentation upon the other. The effect seems to be a disturbance by the positive body of the negative charge of the other, and an attraction of an excess of it to the adjacent surface; and a reverse attraction of the positive charge by the negative body. But the real effect is unquestionably that above described, each body producing an inductive effect upon the other without regard to its charge, and this effect being added to or deducted from the charge.

(To be continued.)

II. A HANDFUL OF "NUCES ZOOLOGICÆ," AND THEIR "CRACKING."*

By J. W. Slater.

WHO has not seen, or at least heard of, animals, when in some position of real or imaginary danger, shamming death? A fox, after being shot at and wounded, has been known to lie motionless and inert, and to give no sign of life even if handled and lifted up. But if left unnoticed for a time he has been found to have disappeared. The pretended death of the opossum has become proverbial. A dung-beetle, if surprised away from his burrow, stretches out his legs in the stiff and ungainly posture which his race take when dead. Numbers of other Coleoptera, if startled by the approach of a hand, by a passing shadow (as of a bird flying over), fold in their legs close to their body, and remain motionless, or perhaps drop from the spray, tree-trunk, or wall on which they may have been sitting, and may easily be mistaken (*e.g.*, *Byrrhus pilularius*) for a little lump of dirt. Such instances might be multiplied to an indefinite extent were there any question about the facts themselves. But the difficulty lies elsewhere. Why do such

* Trance and Trancoidal States in the Lower Animals. By G. M. Beard, A.M., M.D. New York: W. L. Hyde and Co.

animals counterfeit death? Here we have a variety of theories more or less ingenious. In the fox and the opossum such conduct is generally pronounced a stratagem, consciously and intentionally adopted in the expectation that their captors or enemies, human or brute, may be thrown off their guard, and may thus allow the victim a chance of escape. I am not prepared to deny that this may be at times actually the case. But in a majority of instances "sham death" finds, as will be seen below, a simpler explanation.

With insects, many naturalists still take refuge in the cabalistic word "instinct." The stratagem has been, it is contended, either Divinely implanted in these creatures for their protection, or else it has been developed in them by "natural selection." But does it protect? The insect which drops apparently lifeless from a twig or flower may certainly escape an approaching bird, and is quite as likely to fall into the web of a spider, where its death-like attitude will avail it little. It has been said that rooks, magpies, jays, and the like, will not pick up a dead beetle, and that these insects may often be left unnoticed by their taking the attitude of death. This supposition, if it ever holds good, is not universally correct. When conducting some experiments at the Leeds Sewage Works, in the summer of 1876, I saw a dead *Geotrupes stercorarius* lying on the ground near one of the tanks, with his legs extended as ungracefully as the limbs of a mediæval saint in an illuminated manuscript. I picked him up, satisfied myself that he was really dead, and threw him down again. Soon afterwards I saw a flight of rooks parading about near where the dead beetle was lying, and on again making the circuit of the tanks I saw that his dead body had been pecked to pieces, and that all the soft parts had been eaten. Hence I conclude that rooks will eat dead beetles, and that as against them "shamming death" is not of the slightest use as a means of protection. I submit therefore that the "protective instinct" theory does not hold good.

There are certain other admitted facts which often do duty not as proofs of animal intelligence, but of its very antithesis—animal stupidity. It has been proved, by a number of authenticated cases, that animals placed in great and unwonted danger seem to lose all traces of their ordinary sagacity, and instead of taking a very easy way of escape they remain rooted to the spot, or even rush headlong into destruction. Many painful instances have shown how difficult it is to get horses out of a burning stable: so far from

coming out when the door is set open, they refuse even to be dragged out. Cats, for all their caution and agility, have been known to rush right into a burning house, though many ways of escape were open.

Many years ago, when on the ridge of a mountain in Austria, I saw a fox appear out of a thicket and run along a track leading straight down the slope. As no divinity hedges in the life or the well-being of Reynard in the Dual Monarchy, I took the liberty of setting a large fragment of rock rolling down after him. He fled in terror, but still kept in the same track, and not until the stone was close upon him did he bound to one side, and with a loud yelp disappear in the bushes.

In the year 1879 I noticed a dog fleeing along the Aylesbury and Buckingham Railway, just in front of a train. At any point, by turning to the right or the left, he could have escaped all danger, but he still ran straight on and was almost overtaken. The engine-driver, espying him, slightly reduced speed, when the dog at last came to his senses sufficiently to turn at a level crossing and run along a lane, still plainly in a state of the greatest affright.

Are these and similar events proofs of animal stupidity, or are they not rather to be referred to the same cause as the appearance of death above mentioned?

Another somewhat allied class of phenomena here suggest themselves. The strange influence which a bright light displayed amidst darkness has upon many insects, birds, fishes, and even some mammals, is a most familiar fact. This attraction towards light is particularly experienced by nocturnal animals; but diurnal species, if travelling in the night, are similarly affected. The importunity with which insects will rush towards and seek to force their way into a flame has been utilised not merely for the capture of rarities, but has been applied on the large scale for the destruction of noxious species. Birds are frequently known to dash themselves—sometimes fatally—against the windows of a lighthouse, and this takes place not merely in storms, but in fine weather. Owls have been known to flutter against the windows of a sick chamber in the night. This has been superstitiously regarded as an omen of death, and certain *demi-savans*—seeking to explain away this piece of folk-lore—have made matters worse by suggesting that the owl smells the approach of death, and comes in the hope of feasting on the body. To this theory there are two fatal objections: the owl hunts by the eye, not by scent, and, so

far from being attracted by decomposing animal matter, it will eat nothing which has the slightest taint.

Fish are often caught from a boat carrying torches. The fishes sometimes leap on board, or else are attracted sufficiently near to be speared or captured with a landing-net or by hand.

Certain Mammalia, such as deer, are sometimes—according to Dr. Beard—shot in the night by the aid of a strong light fixed on the hat of the hunter, or in the bow of a boat which is pulled along the shore of a woodland river. Says Dr. Beard, "The conditions for success in this sport are a light boat with boatmen in the stern who pull in a noiseless manner: the hunter in the bow of the boat must also keep perfectly still, holding himself in position to be in readiness to shoot whenever the deer at the water's edge becomes dazed by the light. Other animals are sometimes hunted in the same way."

The attempts at explaining this attraction of light have, so far, not been too happy. The propensity to rush into a fire is so manifestly to the disadvantage of the animals concerned that the "instinct" abracadabra has not here been tried. Some naturalists have suggested that the moth takes the flame of the lamp for an opening through which it may escape into the light. But moths and nocturnal insects generally are quite at home in the dark, and remain during the day dormant. Why should they seek to escape into what they otherwise avoid?

Another suggestion, on the attempted verification of which I have spent no little time, is this:—All flowers are in the night phosphorescent to the delicate vision of insects, who consequently where they see light expect to find honey. Notwithstanding the flaw in this hypothesis, that many insects and birds which are attracted by a light do not feed upon honey or pollen, I have tested it experimentally by trying the effects of phosphorescent light upon insects, and by endeavouring to prove whether flowers generally, after exposure to sunshine, became phosphorescent during darkness. In neither respect were the results decisive. Hence it is satisfactory to find the light-seeking of nocturnal birds, fishes, and insects accounted for on a simple principle which applies to all cases.

There are, it must be remembered, other nocturnal animals upon which a light acts in a different manner. Instead of being attracted, they are put to flight. The flame is recognised as something unusual and to be avoided, but it does not daze and bewilder. This is the case with most of the

larger beasts of prey, and with many serpents. I have read, on doubtful authority, of a Brazilian snake which—instead of being either repelled or stupefied by a fire kindled in the forests—endeavours to extinguish it by knocking the burning sticks asunder.

Another puzzling phenomenon is the alleged fascination exercised by serpents, to which some men are even said to have found themselves subject. The facts here have been called in question. Still a number of witnesses, generally trustworthy, tell us that they have seen birds, frogs, squirrels, &c., remain as if paralysed on the approach of a serpent, and in some cases even rush into its jaws. Some persons declare that they have been unpleasantly affected by the cold, fixed, stony glare of a serpent's eyes, and have felt a kind of torpor steal over them which it required a strong effort of the will to overcome. Experimentally I have repeatedly fixed my eyes on those of serpents, but have felt nothing of the sensation above mentioned. One element, however, was wanting to make the experiment complete: I felt no mysterious dread of the serpents.

Not alone snakes, however, but many predatory animals, are said sometimes to paralyse their intended prey by a fixed gaze, though here, too, decisive cases are wanting.

In a very similar manner the fixed gaze of the human eye has unquestionably a peculiar effect upon many animals,—such as lions, tigers, leopards, &c.,—and has often deterred them from making an attack. Dr. Beard refers to the case of a "lion-tamer" who was accidentally torn to pieces by a leopard during one of those foolish and reprehensible performances which prove, by their popularity, that the taste for the games of the old Roman circus is by no means absent in this virtuous community. We come as near to them as the law allows, hoping in our heart of hearts that some accident will supply that little *soupçon* of blood which seems to complete the relish craved for by the multitude.

To what species this deterrent effect of the human eye extends is a point not yet determined. I doubt whether it would have any effect upon a bear, a wild boar, a Cape buffalo, or a gorilla. Certainly it has no action upon that semi-human being the British rough, at least when assembled in a group. Men of the world generally agree that one of the most essential precautions to escape injury, when meeting a gang of such ruffians in a lonely place, is to avoid catching the eye of any of them.

We are naturally reminded here of the superstition of the

"evil eye," still widely prevalent in the Mediterranean Basin, in Eastern Europe, and in many parts of Asia.

A fixed gaze was in the Middle Ages accounted one of the many means by which the sorcerer, or the fiend in human shape, could gain power over his intended victim. In the witch-trials it was a principle that the judges should particularly avoid catching the eye of the accused, lest they might lose the power of condemning, or of passing a sufficiently rigorous sentence.

Serpent-charming is another curious fact. Setting aside the jugglery and the downright fraud with which the question has been complicated, there seems to be little doubt but that by the production of certain shrill but monotonous sounds, such as whistling, the most vicious snakes—*e.g.*, the redoubtable cobra—can be drawn from their holes and lulled into a dreamy state, during which they are harmless. The iguana, a large lizard found in the tropical regions of the western continent, is captured by means of whistling. The lizard listens intently, and ceases to pay attention to anything else, till a noose is slipped round his neck.

These facts are naturally connected with certain phenomena which have been experimentally produced both in the lower animals and in man, and upon which no little nonsense has been talked and written.

It was at one time a not uncommon trick to lay a hen upon a table, with her breast, neck, and the under side of her beak resting flat upon the surface, whilst a chalk line was drawn upon the table from the point of her beak onwards. On the operator removing his hands the bird generally remained motionless in this awkward position, squinting ludicrously at the chalk line. This experiment is now never performed, and may, for anything I know, fall within the provisions of the well-known Vivisection Act.

Very similar results may be produced both on birds and mammals. The subject operated upon is bewildered by finding itself temporarily placed in some unusual position where motion is impossible, and on being released it does not offer to move. The horse-taming operations of Rarey and others are referred by Dr. Beard to the same class. He remarks, "The horse is a timid and—save in narrow lines, as in memory of places—a stupid animal, else he could not be so easily frightened and subdued." How widely this assertion differs from the popular view need scarcely be stated; but it has often been noticed that, as regards the lower animals, man is apt to confound docility with intelligence.

Some years ago a series of experiments were publicly performed on human subjects, under the painfully absurd name "Electro-Biology." A small disk of copper and zinc, soldered together, was placed in the hand of the person operated upon, and he was told to fix his eyes and his attention steadfastly upon the metals. After a time a certain proportion of the subjects were found to have lost all power over themselves, and had become mere passive instruments in the hands of the operator. A boy in this state was told that he was in darkness: on holding a candle to his face the pupils of his eyes did not contract in the least. These results were ascribed to Electricity, which is invoked to yield an explanation for almost as many ill-observed phenomena as is Instinct. Soon it was found that a disc of a single metal, a coin, a ring, a pebble, a cork, in fact any small object whatever, would answer the same end if persistently gazed at.

All the above phenomena, and many of a similar nature, are referred by Dr. Beard to trance, or a state approaching thereto, for which the author proposes the name "trancoidal" state—an ugly word, for which I should beg to substitute "tranciform." In all such states, of which there are an endless number of stages, the mental equilibrium of the animal is disturbed, so as to cause an increase of nervous activity in some one direction, often to an exhaustive degree, and of course a corresponding suspension of activity in other directions.

Among the means of promoting this disturbance of mental equilibrium, Dr. Beard enumerates—

1. Acting on the emotion of fear by reducing the animal to helplessness, by tying or confinement of some kind.

   Here, of course, belong the horse-taming feats of Rarey, elephant-taming according to W. H. Cross, and the experiments with birds above mentioned.

2. Making strokes or "passes" on or over an animal.

   Here we have animal magnetism.

3. Steadily fixing the eyes on those of some other person or animal.

   Under this head come lion-taming, tiger-repelling, the evil eye, the fascination exerted by serpents, &c.

4. Presenting to the animal a bright light.

   Under this head fall the refusal, or, more accurately speaking, the temporary inability, of horses, cats, and even men, to escape from burning stables, houses, churches, theatres, and the like. It may be here remarked, in passing, that presence of mind is

the absence of liability to have the equilibrium of nervous activity disturbed.

5. Vocal or instrumental music, as shown in serpent-charming, lizard-catching, the efficacy of music in the treatment of mental disease, &c.

Dr. Beard remarks that the only difference between what is called absent-mindedness and the decided trance; in which a person or other animal may remain unconscious even for years, is one of degree. He deserves the warm thanks of naturalists for the light he has thrown on some of the most obscure facts of animal psychology, and for the clean sweep which he has made of certain plausible superstitions.

III. AN ESTIMATE OF AUGUSTE COMTE.

By G. H. C.

SOME thirty years ago the English public was told, by a brilliant and versatile writer, of one who was proclaimed to be "the greatest thinker of modern times," —a man whose doctrine was to the nineteenth something more than that which Bacon's was to the seventeenth and eighteenth centuries." The world heard,—some in undisguised alarm lest the new philosophy should be merely "infidelity" under a fresh disguise. Others listened with eager hope, and a few perhaps with critical reserve. My task to-day is, leaving religious and political speculations to more specially qualified hands, to enquire what has been the outcome of this "Positive Philosophy" as far as Science is concerned? It is well known that Comte did not intend or attempt to furnish in his great work a series of treatises on the various sciences; but he sought to display them in their mutual relations, as a coherent hierarchy, arranged on natural principles. He sketched their history, their present position, and in some sort their future prospects, and expounded their methods, their leading doctrines, and the part each has to play in the education of mankind. No one can dispute either the difficulty or the importance of the undertaking, which if performed aright must have given a powerful

impulse to every science, and been of the greatest value to every inquirer.

To ascertain how far Comte can be pronounced successful in the execution of his task, we must examine his three guiding conceptions:—

He regarded "all the sciences, physical and social, as branches of one Science, to be investigated on one and the same method." The originality of this conception is not very apparent. For a couple of centuries the current of thought had been decidedly moving in that direction; but no one, as far as I am aware, had previously formulated the idea with Comte's distinctness.

The second fundamental conception is proposed as the supreme law of human development:—"There are but three phases of intellectual evolution, for the individual as well as for the mass—the theological (supernatural, or, as I should prefer to say, the personifying), the metaphysical, and the positive." In the first of these stages man seeks the ultimate and final causes of everything. It supposes all surrounding objects animated or sentient. It is curious, I remark, in passing, how this ascription of life and consciousness to all matter is again creeping in among men of high intelligence. In the metaphysical phase phenomena are referred to abstractions or entities, and in the positive phase the mind confines itself to a quest into the laws of phenomena, superadding nothing to what is observed, and dismissing causes and entities as beyond human scope.

It cannot be denied that numbers of instances can be found which seem to agree beautifully with this law. The explosive gas which in our days sometimes shatters a mine, and buries the unfortunate workmen, was in former ages an angry demon, a gnome, or cobold, jealous of human intrusion into his treasure-houses. The fact that the ordinary pressure of the atmosphere counterbalances a column of 32 feet of water, and no more, was at one time explained by the dictum that Nature abhorred a vacuum for the first 32 feet, but not beyond. But on a careful analysis of the rise and progress of Science we do not find these stages as above indicated. Liebig was unable to trace them in the history of chemistry. If we refer to the earliest known documents concerning that science, such as the "Book of the Balance of Wisdom,"* we shall find the records of calm, experimental inquiry, distinctly "positive" in its spirit, and free from anything mystical or fantastic. The strange superstitions and delu-

* Journal of Science, 1876, p. 494.

sions with which we are all so familiar seem to have attached themselves parasitically to the science at a later date.

Or, if we turn to the medical art, the "Papyrus Ebers," dating from the sixteenth century B.C., is "free from hocus-pocus and gibberish. Sorcery was forbidden in the strictest manner, and the alchemistic magi were punished with death under Ramesis III."

Mr. Herbert Spencer, after a careful examination of the genesis of Science, rejects the Comtean phases as specially significant.*

Comte's classification of the sciences is to begin with the most simple and general phenomena, and to proceed to the most complex and particular. The sciences are thus arranged according to their mutual dependence.

Here, also, we are on doubtful ground. If we arrange the so-called primary sciences in Comte's series,—mathematics, astronomy, physics, chemistry, biology, sociology, there is no doubt that those which come later in the rank are indebted to the earlier ones both for methods and for facts, and that the more the nearer they stand together. But there is also indebtedness in the opposite direction. Astronomy is beholden to physics and chemistry for methods of investigating the temperatures, the nature, and even the movements of the heavenly bodies. Biology supplies chemistry with means of determining the molecular constitution of compounds.†

Such cases of mutual obligation are sure to increase. Again, the phenomena of physics are quite as "general" as those of astronomy, since we only recognise the heavenly bodies by the light which they emit or reflect. It is also difficult to conceive that we can anywhere have matter acted on by certain of the forms of energy, such as heat, light, and electricity, without chemical change. Chemical phenomena are thus found co-extensive with those treated of by astronomy and physics.

It would almost appear, from several passages in Comte's works, as if he regarded the general as in its nature higher than the special. We who have been accustomed to trace out how an organism rises by specialisation can scarcely accept a line of reasoning which leads him to conclude that the bookseller deserves a higher rank than the author, the picture-dealer than the artist, and the drysalter than the manufacturer who prepares some delicate colour.

Let us now take a brief survey of Comte's summary views

* Mathematics cannot have had a truly theological or a metaphysical phase.
† *See* Journal of Science, 1881. p. 318.

of certain of the sciences, that we may see what services he has really rendered.

In physics Comte rejects the so-called imponderables. He does not admit, nor does he deny, the existence of the so-called ether whose undulations affect our senses as light. Some credit may belong to him for taking this stand, when it is remembered that at the time when the "Philosophie Positive" was written (1830—1842) many French thinkers still clung to the conception of "caloric" as a substantive entity.

Comte's classification of the respective branches of physics —based professedly, as usual, on "the degree of generality of the corresponding phenomena, on the extent of their complication, their relative states of speculative perfection, and also their mutual dependence"—is not happy. His order is barology, thermology, acoustics, optics, and electricity. It must surely be admitted that the phenomena of light and electricity—the former of which agencies travels through the interstellar spaces, whilst the latter probably pervades all matter—are far more general than those of sound. The classification of the sciences in a linear series, on any principles, will be found practicable only by dint of arbitrary assumptions and by the neglect of obvious considerations.

Electricity Comte considers as forming a natural transition to chemistry. Yet the relations of chemistry and heat are now found no less intimate. Indeed he seems to have little foreseen how physics and chemistry would approximate and almost coalesce in the half-century succeeding the date of his first volume. It is no longer safe to say "Physics treats of masses acting at sensible distances; chemistry treats of molecules acting at insensible distances." In physics we meet with abundant cases of molecular action. Nor are specific differences wanting in the physical properties of bodies. We may take three crystals, one of which, in virtue of its molecular structure, shall cause the plane of polarisation to rotate to the right, the second to the left, whilst the third leaves it unaffected!

Comte maintains that dualism requires to be universally received in chemistry ("Philosophie Pos.," iii. 103—9), even as regards organic compounds. Here, then, we have a want of insight into the future prospects of a science scarcely less striking than he displays in biology by his denial of the mutability of organic species. It is perfectly true that in 1838 dualism was still in the ascendant, but indications were not wanting which might have been sufficient for a man of such

penetrating intellect as Comte is represented by his admirers. Men of the most ordinary stamp can recognise a change when it is formally introduced. From the leading thinkers of the age we expect the power of detecting its first approaches.

We come next to biology, the doctrine of life, which, according to Comte, includes psychology, We cannot take exception to the place which he assigns it, immediately after chemistry and before sociology. He rightly and boldly rejects the standard definitions of life, especially that of Bichat, which cannot be held other than ridiculous :—" Life is the sum of the functions by which death is resisted." But as " death = the termination of life " we may, by introducing this explanation in place of the original term, convert this would-be definition into " Life is the sum of the functions by which the end of life is resisted !" The definition which Comte prefers is that of De Blainville :—" Life is the two-fold internal movement of composition and decomposition, at once general and continuous." It may, however, be urged that no definition of life can be at all complete unless it includes the idea of reproduction. It may further be asked whether the very attempt to define life is not in some measure a departure from the principles of positivism ? We may ascertain the conditions, the laws, the properties of life, but questions as to its nature and its purpose seem to belong to an order which Comte declines to attack.

He decomposes the unhappy discipline formerly known as " organic chemistry," and assigns one part of its subject-matter to chemistry, properly speaking, and the remainder to biology. He regards tissues as being to the animal and plant what molecules are for the chemical compounds. He objects to the life-monads of the physio-philosophers. On the doctrine of cells he is silent. But it must be particularly and regretfully noted that he does not accept the ideas of his great countrymen Buffon and Lamarck, but regards animal and vegetable species as fixed and permanent. He does not, of course, tell us that species were either created as we now find them, or came into existence spontaneously, or that they have existed for ever. To have made such an attempt would have been a departure from the principle which he holds in common with Whewell, Humboldt, and Herschell, that Science does not legitimately deal with origins. How much he has thus missed by failing to appreciate the doctrine of Evolution—a principle which may in future prove no less fruitful in sociology than it has already done in biology—it is not easy to sum up. Had he done so he might have given

a most valuable impulse to organic science. Acting as he did he has given a proof of deficiency in profound philosophic insight; in the spirit which anticipates the future track of discovery. More than this, he has thrown his weight into the scale of the reactionary school of Cuvier. Unless I am greatly misinformed many of the "Positivists" in England and France still think it necessary to reject Evolution. For all this certain sages in England have a hazy kind of notion that "Monsieur Comte" is, in some circuitous manner, an accomplice of Darwin! Did Comte ever take the trouble to give Lamarck's writings a fair examination? An interesting by-question might here be raised: why has France, unlike Britain, Germany, and America, taken so little part in the cultivation of the New Biology? It cannot be entirely due to the personal influence of two eminent naturalists, one of them long ago dead and the other still living. I read lately an anonymous article in which a French zoologist complains of the low position to which the science has fallen in consequence of official alethophobia.

One of the peculiarities of Comte is that he denies to psychology the rank of an independent science. Here it must not be overlooked that he is not followed by his expositor, G. H. Lewes, nor by his admirer (in many respects), John Stuart Mill. Both these writers contend that, should mind be ultimately proved to be merely a function of the nervous centres, the successions and co-existences of mental states are capable of being directly studied without reference to the cerebral changes which may be their immediate antecedents. Even if life is simply a play of matter, thought is a higher phase of life, displaying special phenomena, and admitting, or rather requiring, special study.

We come here to a consideration of Comte's phrenology. Rejecting the ordinary craniological system as originated by Gall, he still holds to the principle that the brain consists of a number of distinct organs, each the seat of some particular faculty. But he assigns each faculty its seat not in consequence of comparative observations, but, as I cannot help saying, arbitrarily,—*i.e.*, according to his own notions as to where they ought to be fixed,—and leaves to anatomists the task of discovering evidence in favour of his system, which so far has not been forthcoming. It is scarcely necessary to say that the Comtean phrenology has to encounter all the difficulties which beset the system of Gall, without its empirical evidence. The two are not in harmony. Comte places the nutritive and the sexual instinct (alimentiveness and amativeness of Gall), the former in the centre of the

cerebellum and the latter in its sides. Benevolence he places at the highest point of the cerebrum, and veneration immediately behind it. It is to be noticed that Comte does not commit the error of denying to animals the possession of the moral sentiments, as do some phrenologists, despite the evidence of these sentiments in their conduct, and despite the fact that their brains—*i.e.*, those of the anthropoid apes—do not differ from our own in the manner and to the extent which this assumption would require.

Now let us turn to the last member of the hierarchy,—sociology. Comte certainly proclaimed that human society had its inherent laws, not dependent upon the caprice of rulers or statesmen, or upon the exertions of demagogues or stump-orators; laws capable of being discovered by the very same methods which we are successfully following in chemistry or in biology.* Few competent judges will here join issue. But has he really placed in our hands a clue capable of being followed up? Are we making any definite progress? Look, for instance, at our Social Science Congress, well characterised as an assemblage "of men who ought to have been women, and of women who wish to be men." Its Transactions are filled not with the attempt to reduce social phenomena under laws capable of verification, and leading to the prevision of facts not yet observed, but with an *olla podrida* of declamation on every subject that can be construed as having any reference to human society, with rhapsodies on sewage-irrigation, woman's rights, coddling criminals, infectious diseases, anti-vaccination, trades'-unionism, and the like,—the whole floating in an opaque and lukewarm whey of self-complacency and mutual admiration. Comte to blame for all this? By no means; but that such farces can still be enacted under the name of "social science" shows that a definite plan has not yet been drawn out.

On no ground has Comte been more strongly and more unjustly denounced than anent his rejection of "political economy." He condemns it as the outcome of a merely critical and negative philosophy, isolating itself from the whole to which it should rightfully belong, and seeking to take its place. In his rejection he seems, however, to me to have been guided by a correct principle. For what is, after all, political economy? Simply the study of man viewed solely as a producer, accumulator, distributor, and

* I cannot find that Comte anywhere recognises the necessity of studying the simpler societies of the lower animals before proceeding to examine the more complicated polity of our own species. Yet he elsewhere lays down principles from which the importance of such a step would plainly follow.

consumer of wealth, all his other functions being disregarded. That such disregard is temporarily justifiable as a scientific artifice for the sake of more convenient study is indisputable. But how if this disregard is carried out into practice? Let me take a parallel case. Let us suppose that nothing were known concerning the anatomy and physiology of man, and that the art of healing had been followed empirically, practitioners observing that when certain symptoms were recognised benefit was obtained by the use of this or the other remedy or appliance. Under such circumstances, if a body of men came to the conclusion that a knowledge of the human system with its various functions were to be desired, it would be perfectly legitimate for them to confine themselves temporarily to the study of some one set of organs. They might, for instance, select in this manner the respiratory apparatus and its laws of action. The truths they might thus ascertain would be, if rightly applied, of great value in medical practice. But suppose that, having reached a moderately accurate knowledge of respiration and its organs, they declined to investigate other functions of the body, and attempted to heal the sick in the sole light of their recent studies, declaring, tacitly at least, that so long as the lungs of a patient were kept in healthy action, the digestive, the circulatory organs, and even the nervous centres might be safely neglected, the result would be quackery of the worst type. But, *mutatis mutandis*, this is precisely what the economists do in attempting to reduce their fraction of a science to practice. Comte felt this, and hence his condemnation of the economists was legitimate.

He proclaimed that the military ecclesiastic *régime* is to be replaced by an industrial and scientific organisation, the workman succeeding to the soldier and the *savant* to the priest. But it does not appear whether he ever asked himself if industrialism is or should be the final haven of the human race. I doubt whether it would be possible to point out a manufacturing and commercial city, province, or country where wealth, either for the few or the many, has not been bought at the price of personal degeneration, physical, moral, and intellectual. Whether industry can ever be so re-organised as not to yield these bitter fruits,—whether it will ever allow man the quietude and the leisure which are absolutely necessary for his full development,—I dare not even guess. Certainly we are not moving in that direction.

It is doubtful whether we can pronounce Comte a friend to Science. He was certainly no discoverer. Though he

assigns to scientific men, or at least to philosophers in his sense of the word, a position something like what was formerly held by the priesthood, he subordinates Science to Emotion. In the words of his whilom interpreter, he considers the "intellectual aspect not the noblest aspect of man." He maintains that "Science is a futile, frivolous pursuit, unworthy of greater respect than a game of chess, unless its issue be in some enlarged conception of man's life and destiny." In other words, he did not feel that love of abstract truth for its own sake, quite independent of man, which actuates the bulk of our great investigators. If Science was not to him exactly—

"Eine tüchtige Kuh die ihn mit Butter versorgt,"

as she is to most of our practical men, who for all that begrudge her pasture, she is, on the other hand, not—

"Die hohe, die himmlische Göttinn."

Here I must avow my dissent. For what is man but a thinking brain, furnished with outward senses as its messengers, with limbs as its agents, and with digestive, circulatory, respiratory, &c., organs to maintain its activity? The lower animals have wills, emotions, but they have no Science; in them the intellect is a servant. In man alone, or at least in the higher man, the relation is inverted. He does not perceive and understand to live, but he lives to perceive and understand the world in which he is placed.

The "Positive Philosophy" can scarcely, as time passes on, and as the excitement which greeted its avatar dies away, be pronounced as marking out any grand epoch in the intellectual history of the world. In comparison with the doctrine of development it appears scantily fruitful in consequences. In its case, as in so many others, results stand in no definite relation, either quantitative or qualitative, to intentions. Just as the advocates of peace have before now brought on a bloody war,—just as the philanthropist often finds that he has been multiplying misery,—just as the enthusiasts who seek to unite all Christian communities into one, simply succeed in generating a new heresy and a new intolerance, so it has been with the doctrine which was to have absorbed all intellectual activity into one harmonious system.

IV. PHYSIOLOGY OF MIND-READING.

By George M. Beard, M.D.

AS "thought-reading" or mind-reading is now being exhibited in this country as an unexplained novelty, and is exciting much sensation, we have great pleasure in inserting the following paper by Dr. G. M. Beard, which, though it had been already published in the "Popular Science Monthly" (February, 1877), has just been sent to us by the author along with an important letter, dated May 31st, from which we extract the following passages:—

"Dr. Carpenter's course in this matter is, as it seems to me, hardly worthy of a scientific man, for he has long been familiar with my investigations in this department; indeed he sent to me for my original papers about two years ago, and he complimented me, in as high terms as one scientific man can bestow upon another, for the original work that I had done in this and allied departments of science. Now when the subject is brought up he nowhere recognises my discoveries which previously he had quoted with high approval, but allows the credit to fall upon himself by implication, or lets the matter remain undecided.

"I have written a letter to the "Lancet" on the subject, and have also sent them a copy of this essay, which was published in 1877.

"Irving Bishop was in America at the time I was making my researches, and had conversations with me about them, and gained what he knew from my studies and from the performances of 'Brown the mind-reader.'"

In the history of science, and notably in the history of physiology and medicine, it has often happened that the ignorant and obscure have stumbled upon facts and phenomena which, though wrongly interpreted by themselves, yet, when investigated and explained, have proved to be of the highest interest. The phenomena of the emotional trance, for example, had been known for ages; but not until Mesmer forced them on the scientific world, by his public exhibitions

and his ill-founded theory of animal magnetism, did they receive any serious and intelligent study. Similarly the general fact that mind may so act on body as to produce involuntary and unconscious muscular motion was by no means unrecognised by physiologists, and yet not until the "mind-reading" excitement two years ago* was it demonstrated that this principle could be utilised for the finding of any object or limited locality on which a subject, with whom an operator is in physical connection, concentrates his mind.

Although experiments of this kind had been previously performed in a quiet limited way, in private circles, yet very few had heard of or witnessed them; they were associated in the popular mind very naturally with "mesmerism," and by some were called "mesmeric games." The physiological explanation had never been even suggested; hence the first public exhibitions of Brown, with his successful demonstrations of his skill in this direction, were a new revelation to the scientific world in general.

The method of mind-reading introduced by Brown, which is but one of many methods that have been used, is as follows:—

The operator, usually blindfolded, firmly applies the back of the hand of the subject to be operated on against his own forehead, and with his other hand presses lightly upon the palm and fingers of the subject's hand. In this position he can detect, if sufficiently expert, the slightest movement, impulse, tremor, tension, or relaxation, in the arm of the subject. He then requests the subject *to concentrate his mind* on some locality in the room, or on some hidden object, or on some one of the letters of the alphabet suspended along the wall. The operator, blindfolded, marches sometimes very rapidly with the subject up and down the room or rooms, up and down stairways, or out-of-doors through the streets, and, when he comes near the locality on which the subject is concentrating his mind, a slight impulse or movement is communicated to his hand by the hand of the subject. This impulse is both involuntary and unconscious on the part of the subject. He is not aware that he gives any such impulse; and yet it is sufficient to indicate to the expert and practised operator that he has arrived near the hidden object, and then, by a close study and careful trials in different directions, upward, downward, and at various points of the compass, he ascertains precisely the locality, and is, in many cases, as confident as though he had received

* *I.e.* 1875.

verbal communication from the subject. Even though the article on which the subject concentrates his mind be very small, it can frequently be picked out from a large number, provided the subject be a good one, and the operator sufficiently skilful. The article is sometimes found at once, the operator going to it directly, without hesitation, and with a celerity and precision that, at first sight, and until the physiological explanation is understood, justly astonish even the most thoughtful and sceptical. These experiments, it should be added, are performed in public or private, and on subjects of unquestioned integrity, in the presence of experts, and under a combination of circumstances and conditions for the elimination of error that make it necessary to rule out at once the possibility of collusion.

The alternative is, therefore, between the actual transfer of thought from subject to operator, as has been claimed, and the theory of unconscious muscular motion and relaxation on the part of the subject, the truth of which I have demonstrated by numerous experiments.

One of the gentlemen with whom I have experimented, Judge Blydenberg, who began to test his powers directly after I first called public attention to the subject in New Haven, claims to succeed, even with the most intellectual persons, provided they fully comply with the conditions, and honestly and persistently concentrate their minds. One fact of interest is the exceeding minuteness of the objects that he finds. A large number of the audience empty their pockets on the table, until it is covered with a medley of keys, knives, trinkets, and miscellaneous small objects. Out of them the subject selects a small seed a little larger than a pea, and even this the operator, after some searching, hits precisely.

One may take a large bunch of keys, throw them on the table, and he picks out the very one on which the subject concentrates his mind.

Another fact of interest in his experiments is that, if the subject thinks over a number of articles in different parts of the room, and finally selects some one, the operator will lead him, sometimes successively, to the different objects on which he has thought, and will wind up with the one that he finally selected. He also performs what is known as the "double test," which consists in taking the hand of a third party, who knows nothing of the hidden object, but who is connected with another party who does know, and who concentrates his mind upon it. The connection of these two persons is made at the wrist, and the motion is communi-

cated from one to the other through the arms and hands. The "double test" has been regarded by some as an argument against the theory that this form of mind-reading was simply the utilising of unconscious muscular motion on the part of the person operated upon.

This gentleman represents that the sensation of muscular thrill is very slight indeed, even with good subjects; and, in order to detect it, he directs his own mind as closely as possible to the hand of the subject.

In all these experiments, with all mind-readers the requirement for the subject to concentrate the mind on the locality agreed upon is absolute; if that condition is not fulfilled, nothing can be done, for the very excellent reason that, without such mental concentration, there will be no unconscious muscular tension or relaxation to guide the operator.

I have seen a performer—far less skilful than many with whom I have experimented—take a hat from the head of a gentleman in a small private circle, and carry it across the room and put it on the head of another gentleman; take a book or any other object from one person to another; or go in succession to different pictures hanging on the wall, and perform other feats of a similar character, while simply taking hold of the wrist of the subject. In the experiment described by Mr. Grimes the subject placed three fingers of his right hand on the shoulder of the operator. Note the fact that in all these experiments *direction* and *locality* are all that the mind-reader finds; the quality of the object found, or indeed whether it be a movable object at all, or merely a limited locality, as a figure in the carpet or on the wall, is not known to the mind-reader until he picks it up or handles it: then if it be a small object, as a hat, a book, a coin, or tidy, he very naturally takes it and moves off with it in the direction indicated by the unconscious muscular tension of the subject, and leaves it where he is ordered by unconscious muscular relaxation. In the great excitement that attends these novel and most remarkable experiments the entranced audience fail to notice that the operator really finds nothing but *direction* and *locality*.

I have said that various errors of inference, as well as of observation, have been associated with these experiments. A young lady who had been quite successful as an amateur in this art was subjected by me to a critical analysis of her powers before a large private audience. She supposed that it was necessary for all the persons in the audience to concentrate their minds on the object as well as those whose

hands were upon her. I proved by some decisive experiments, in which a comparison was made with what could be done by chance alone, that this was not necessary, and that the silent, unexpressed will of the audience had no effect on the operator, save certain nervous sensations created by the emotion of expectancy. Similarly, I proved that, when connected with the subjects by a wire, she could find nothing, although she experienced various subjective sensations, which she attributed to "magnetism," but which were familiar results of mind acting on body.

Another lady, who is quite successful in these experiments, thought it was necessary to hide keys, and supposed that "magnetism" had something to do with it. I told her that that was not probable, and tried another object, and found that it made no difference what the object was. She supposed that it was necessary that the object should be secreted on some person. I found that this also was not necessary. She does not always succeed in finding the exact locality at once, but in some cases she goes directly to it; she very rarely fails.

In order to settle the question beyond dispute whether unconscious muscular action was the sole cause of this success in finding objects, I made the following crucial experiments with this lady:—Ten letters of the alphabet were placed on a piano, the letters being written on large pieces of paper. I directed her to see how many times she would get a letter which was in the mind of one of the observers in the room correctly by chance purely, without any physical touch. She tried ten times, and got it right twice. I then had her try ten experiments with the hand of the person operated on against the forehead of the operator, the hand of the operator lightly touching against the fingers of this hand, and the person operated on concentrating her mind all the while on the object, and looking at it. In ten experiments, tried this day, with the same letters, she was successful six times. I then tried the same number of experiments with a wire, one end being attached to the head or hand of the subject, and the other end to the head or hand of the operator. The wire was about ten feet long, and was so arranged—being made fast at the middle to a chair—that no unconscious muscular motion could be communicated through it from the person on whom she was operating. She was successful but once out of ten times. Thus we see that by pure chance she was successful twice out of ten times; by utilising unconscious muscular action in the method of Brown she was successful six times out of ten.

When connected by a wire she was less successful than when she depended on pure chance without any physical connection. In order still further to confirm this, I suggested to this lady to find objects with two persons touching her body in the manner we have above described. I told these two to deceive her, concentrating their minds on the object hidden, at the same time using conscious motion toward some other part of the room. These experiments, several times repeated, showed that it was possible to deceive her, just as we had found it possible to deceive other muscle-readers.

It is possible to become quite an adept in this art without suspecting, even remotely, the physiological explanation. The muscular tension necessary to guide the operator is but slight, and the sensation it produces may be very easily referred by credulous, uninformed operators to the passage of "magnetism;" and I am sure that with a number of operators on whom I have experimented this mistake is made. Some operators declare that they cannot tell how they find the locality, that their success is to them a mystery. Other operators speak of thrills or vibrations which they feel, auras and all sorts of indefinable sensations. These manifold symptoms are purely subjective, the result of mind acting on the body, the emotions of wonder and expectancy developing various phenomena that are attributed to "animal magnetism," "mesmerism," or "electricity"—to everything but the real cause. I have seen amateurs who declared that they experienced these sensations when trying without success to "read mind" through the wires, or perhaps without any connection with the subject whatever.

The facts which sustain the theory that the so-called mind-reading is really muscle-reading—that is, unconscious muscular tension and relaxation on the part of the subject—may be thus summarised:

1. Mind-readers are only able to find *direction* and *locality*, and, in order to find even these, they must be in physical connection with the subject, who must *move* his body or some portion of it—as the fingers, hand, or arm. If the subject sits perfectly still, and keeps his fingers, hand, and arm perfectly quiet, so far as it is possible for him to do so by conscious effort, the mind-reader can never find even the *locality* on which the subject's mind is concentrated; he can only find the *direction* where the locality is. Mind-readers never tell what an object is, nor can they describe its colour or appearance; *locality*, and nothing more definite than locality, is all they find. Again, where connection of the operator with the subject is made by a wire, so arranged

that mass-motion cannot be communicated, and the subject concentrates his mind ever so steadily, the operator does just what he would do by pure chance, and no more. This I have proved repeatedly with good subjects and expert performers.

2. The subject can successfully deceive the operator in various ways—first of all, by using muscular tension in the wrong direction, and muscular relaxation at the wrong locality, while at the same time the mind is concentrated in the right direction. To deceive a good operator in this way is not always easy, but after some practice the art can be acquired, and it is a perfectly fair test in all experiments of this nature.

Yet another way to deceive the mind-reader is, to think of some object or locality at a great distance from the room in which the experiments are made, and, if there be no ready means of exit, the performer will be entirely baffled. I am aware that some very surprising feats have been done in the way of finding distant out-of-door localities by muscle-readers, but in these cases there has usually been an implied understanding that the search was to be made out-of-doors; muscle-readers have thus taken their subject up and down stairs or from one room or hall into another, and out-of-doors until the house or locality was reached.

Another way in which deception may by practised is for the subject to select some object or locality on the person of the muscle-reader. If such a selection be made, and the method of physical connection above described be used, the experiment will be a failure, provided the muscle-reader does not know or suspect that an object on his own person is to be chosen. Similarly, if the subject selects a locality on his own person, as one of the fingers or finger-nails of the hand that connects with the muscle-reader. When such tests are used, there is not, so to speak, any leverage for the tension of the arm toward the locality on which the mind is concentrated, and the muscle-reader either gets no clue, or else one that misleads him.

3. When a subject, who has good control over his mental and muscular movements, keeps the arm connected with the operator *perfectly stiff*, even though his mind be well concentrated on the hidden object, the operator cannot find either the direction or the locality. This is a test which those who have the requisite physical qualifications can sometimes fulfil without difficulty.

Here I may remark that the requirement to concentrate the mind on the locality and direction sought for all the

time the search is being made is one that few can perfectly fulfil. Any number of distracting thoughts will go through the best-trained mind of one who, in company with a blindfolded operator, is being led furiously up and down aisles, halls, streets, and stairways, fearful each moment of stumbling or striking his head, and followed, it may be, by astonished and eager investigators. And yet these mental distractions do not seem to interfere with the success of the experiment unless the arm is kept studiously rigid, in which case nothing is found save by pure chance. Credulous, wonder-loving subjects are sometimes partially entranced through the emotions of reverence and expectation; with subjects in this state operators are quite sure to succeed.

4. The uncertainty and capriciousness of these experiments, even with expert operators, harmonise with the explanation here given. Even with good subjects all mind-readers do not uniformly succeed; there is but little certainty or precision to the average results of experiments, however skilfully performed. Even in the successful tests the operator usually must try various directions and many localities, sometimes for ten or fifteen minutes, before he finds the locality sought for; cases where the operator goes at once in the right direction, stops at the right locality, and *knows* when he has reached it, are exceptional.

5. Many of those who become expert in this art are aware that they succeed by detecting slight muscular tension and relaxation on the part of the subject.

Some operators have studied the subject scientifically, and are able to analyse with considerable precision the different steps in the process.

6. A theoretical and explanatory argument is derived from the recent discovery of motor centres in the cortex of the brain.

I was repeating the experiments of Fritsch and Hitzig at the time when my attention was first directed to the remarkable exhibitions of Brown, and the results of my studies in the electrical irritation of the brains of dogs and rabbits suggested to me the true explanation of mind-reading before any opportunity had been allowed for satisfactory experiments.

The motto "when we think we move," which I have sometimes used to illustrate the close and constant connection of mind and body, seems to be justified by these experiments on the brain, and may assist those who wish to obtain a condensed statement of the physiology of mind-reading. Taking into full consideration the fact that all physiologists

are not in full accord as to the interpretation to be given to these experiments, whether, for example, the phenomena are due to direct or reflex action, still it must be allowed, by all who study this subject experimentally, that thought-centres and muscle-centres are near neighbours, if not identical.

In all these experiments it should be observed there is no one muscle, there is no single group of muscles, through which this tension and relaxation are developed; it is the finger, the hand, the arm, or the whole body, according to the method employed. Among the various methods of making connection between the subject and operator are the following:—

1. The back of the subject's hand is held firmly against the forehead of the operator, who with his other hand, lightly touches the fingers of the subject's hand. (Brown.)

This is, undoubtedly, the most artistic of all known methods.

2. The hand of the operator loosely grasps the wrist of the subject.

This is a very inartistic method, and yet great success is oftentimes attained by it.

3. One finger of the operator is applied to one finger of the subject, papillæ touching papillæ.

This is a modification of the first method; by it exceedingly small objects or localities are found.

4. The operator is connected in the usual way with a third party who does not know the locality thought of by the subject, but is connected with the subject by the wrist ("double test").

In this experiment, which astounded even the best observers, the unconscious muscular motion was communicated from the subject to the arm of the third party, and through the arm of the third party to the operator.

5. Two, three, or more subjects, who agree on the locality to be thought of, apply their hands to the body of the operator in front and behind.

This method is excellent for beginners, and the direction is easily found by it; but it is obviously not adapted for the speedy finding of small objects; it is frequently used by ladies.

6. The hand of the subject lightly rests on the shoulder of the operator.

In all these methods the operator is usually blindfolded, so that he may get no assistance from any other source than the unconscious muscular action of the subject.

The movements of the operator in these experiments may be either very slow, cautious, and deliberate, or rapid and reckless. Brown, in his public exhibitions, was very careful about getting the physical connection right, and then moved off very rapidly, sometimes in the right direction, sometimes in the wrong one, but frequently with such speed as to inconvenience the subject on whom he was operating. These rapid movements serve, no doubt, in many cases, to bewilder or partially entrance the subject, and thus to render him far more likely to be unconscious of his own muscular tension and relaxation through which the operator is guided.

The power of muscle-reading depends mainly, if not entirely, on some phase of the sense of touch.

Every physician recognises the fact of this difference of susceptibility to touch ; and, in the diagnosis of certain conditions of disease, much depends on the *tactus eruditus.* I am not sure whether this delicacy of perception, by which muscle-reading is accomplished, is the ordinary sense of touch, that of contact, or of some of the special modifications of this sense. It is to physiologists and students of diseases of the nervous system a well known fact that there are several varieties of sensibility—to touch, to temperature, to pressure or weight, and to pain—which, possibly, represent different rates or modes of vibration of the nerve-force.

The proportion of persons who can succeed in muscle-reading, by the methods here described, is likewise a natural subject of inquiry. It is probable that the majority of people of either sex, between the ages of fifteen and fifty, could attain, if they chose to labour for it, under suitable instruction, a certain grade of skill as muscle-readers, provided, of course, good subjects were experimented with. It is estimated that about one in five or ten persons can be put into the mesmeric trance by the ordinary processes ; and, under extraordinary circumstances, while under great excitement, and by different causes, every one is liable to be thrown into certain stages or forms of trance ; the capacity for the trance-state is not exceptional ; it is not the peculiar property of a few individuals—it belongs to the human race ; similarly with the capacity for muscle-reading. The age at which this delicacy of touch is most marked is an inquiry of interest ; experience, up to date, would show that the very young or the very old are not good muscle-readers.

In these mind-reading experiments, as indeed in all similar or allied experiments with living human beings, there are six sources of error, all of which must be absolutely

guarded against if the results are to have any precise and authoritative value in science.

1. The involuntary and unconscious action of brain and muscle, including trance, in which the subject becomes a pure automaton. I have used the phrase "involuntary life" to cover all these phenomena of the system that appear independently of the will. The majority of those who studied the subject of mind-reading—even physicians and physiologists—failed through want of a proper understanding or appreciation of this side of physiology.

2. Chance and coincidences. Neglect of this source of error was the main cause of the unfortunate results of the wire and chain experiments with mind-readers.

3. Intentional deception on the part of the subject.

4. Unintentional deception on the part of the subject.

5. Collusion of confederates. To guard against all the above sources of error it is necessary for the experimenter himself to use deception.

6. Unintentional assistance of audience or bystanders.

When the muscle-reader performs before an enthusiastic audience, he is likely to be loudly applauded after each success; and, if the excitement be great, the applause, with shuffling and rustling, may begin before he reaches the right locality, while he is approaching it; when, on the other hand, he is far away from the locality, the audience will inform him by ominous silence. The performance thus becomes like the hide-and-seek games of children, where they cry "Warm!" as the blindfolded operator approaches the hidden object; "Hot!" as he comes close to it; and "Cold!" when he wanders far from it. Some of the apparent successes with the wire-test may be thus explained.

In regard to all the public exhibitions of muscle-readers, it should be considered that the excitement and *eclat* of the occasion contribute not a little to the success of the operator; the subjects grow enthusiastic—are partly entranced, it may be—become partners in the cause of the performer—and unconsciously aid him far more than they would do in a similar entertainment that was purely private. In a private entertainment of muscle-reading at which I was present, one of the subjects, while standing still, with his hands on the operator, actually took a step forward toward the locality on which his mind was concentrated, thus illustrating in a visible manner the process by which muscle-reading is made possible.

The subject under discussion, it will be observed, is to be studied both inductively and deductively. The general claim

of mind or thought reading is disproved not by any such experiments as are here detailed, no matter how accurate or numerous they may be, but by reasoning deductively from the broad principle of physiology, that no human being has or can have any qualities different in *kind* from those that belong to the race in general. The advantage which one human being has over another—not excepting the greatest geniuses and the greatest monsters—is, and must be, of degree only. Mind-reading, in the usual meaning of the term, is a faculty that in any degree does not belong—indeed, it is never claimed that it belongs—to the human race; it cannot, therefore, belong to any individual. For one person to read the thoughts of another would be as much a violation or apparent violation of the laws of Nature as the demonstration of perpetual motion, the turning of iron into gold, or the rising of the sun in the west. Experiments such as here recorded, if made for the purpose of ascertaining whether certain persons have the power of reading thoughts, would be more than unnecessary; they would be exceedingly unscientific. Reasoning deductively also from the known laws of the involuntary life, the power to read muscles, in the method here described, is not only possible and probable, but inevitable. Everybody is a muscle-reader, although all are not capable of attaining the highest degrees of skill in the art.*

The one fact, the only fact brought out by these experiments that could not be predicted from known laws of physiology, is the exceeding refinement to which muscle-reading can be carried, the minuteness of the localities that are found, and the rapidity with which, oftentimes, the results are obtained. This fact is of permanent value to science, a new and positive addition to the physiology of the involuntary life, and of vast suggestion in relation to the general subject of the interactions of mind and body in health and in disease.

An incidental fact impressed on my mind during these researches was the prevalence and the power of the belief in animal magnetism. This delusion may well be regarded as the witchcraft of the nineteenth century; its hand is everywhere—on the press and the pulpit, on all our literature, on science itself, even on physiology, to which its phenomena rightly belong, and by which they can be and are fully

* Every horse that is good for anything is a muscle-reader; he reads the mind of his driver through the pressure on the bit, and by detecting tension and relaxation knows when to go ahead, when to stop, and when and which way to turn, though not a word of command is uttered.

explained. It is a tyrant that rules over the whole realm of the seemingly mysterious; the success of the orator on the platform, and of the physician at the bedside, is attributed to its aid, as of old superior learning and skill were attributed to the occult forces of magic. It may be doubted whether any other false belief of our time has had a more serious influence in retarding the progress of right reasoning than this, since it blocks the doors of investigation and prejudges the case when investigations are made, stimulates the too common habit of making the emotions do the work of the intellect, and becomes a sort of foster-mother to other and allied delusions.

It was the universality of this belief in animal magnetism that made mind-reading popular, since it furnished a basis as broad as the wildest theoriser could wish, on which could be erected a limitless variety of hypotheses; and many who rejected intuitively the claim of direct supernatural aid were made happy by the equally false and untenable claim of literal conveyance of thought from subject to operator through the agency of a supposed magnetic fluid.

ANALYSES OF BOOKS.

Illusions: a Psychological Study. By JAMES SULLY. London: C. Kegan Paul and Co.

To recognise illusions, to understand their origin, and to avoid them, is the part of the wise man, just as their unscrutinising acceptance is the task of the fool, and their propagation that of the quack and the knave. Hence the work before us should have an exceedingly wide interest. The author tells us that at bottom illusion becomes identified with fallacious inference. He says, too truthfully, that "our luminous circle of rational perception is surrounded by a misty penumbra of illusion." It must not, however, be supposed that Mr. Sully is one of those who, in language common to ultra-sceptical philosophers and to ultra-devout hymnwrights, proclaim—

> "This world is all a fleeting show
> For man's illusion given."

Whilst declaring that we have "found a large field for illusory cognition in sense-perception, in the introspection of the mind's own feelings, in the reading of other's feelings, and finally in belief," he holds that illusion has its limits. He admits that "our intuitions of external realities, our indestructible belief in the uniformity of Nature, in the nexus of cause and effect are at least partially true,—true in relation to certain features of our common experience. At the worst they can only be called illusory as slightly misrepresenting the exact results of this experience. And so in full view of the subtleties of philosophic speculation, the man of science may still feel justified in regarding his standard of truth, a stable concensus of belief as above suspicion."

Mr. Sully classifies illusions according to their origin, obtaining four classes corresponding with four forms of cognition. Thus we have illusions of external perception, of internal perception, of memory, and of belief.

We shall turn our attention, in the first place, to the illusions of memory. The author distinguishes, as something quite apart from mere forgetfulness or from imperfect remembrance, three classes of illusions. "We may have false recollections, to which there correspond no real events of personal history; others which misrepresent the manner of happening of the events, and others

which falsify the date of the events remembered." We are in some doubt whether the date of an event should not, like its locality, and like the actors, sufferers, or other participators in the events, be simply included under the "manner of happening." However this may be, we shall find persons who will readily admit that they have forgotten the whole or a part of some occurrence, but who will yet maintain that so much of it as they do recollect must be an accurate transcript of the reality. Careful self-examination will, however, convince any of us that such is by no means the fact. As the author points out, a disputant will sometimes exclaim "I either witnessed the occurrence or else I dreamt it." A careful man may have in his memory matter which he does not like to mention, because he is not sure whether it is a portion of his personal experience, a relic of a dream, or something which he has heard or read.

Concerning one class of the spectra of memory—to wit, the dim recollections of a former life—the author makes an interesting suggestion. It is well known that the occasional occurrence of such shadowy reminiscences has been urged in favour of the doctrine of metamorphosis.* But says Mr. Sully, "May it not happen that, by the law of hereditary transmission which is now being applied to mental as well as bodily phenomena, ancestral experiences will now and then reflect themselves in our mental life, and so give rise to apparently personal recollections?" As an instance we quote the following letter, communicated to us by a friend whose name we are not at liberty to bring forward:—"In my fourteenth year," he writes, "my father judged that a knowledge of the Spanish language would be useful to me in after life. At the very first lesson the words and the sounds seemed to me strangely familiar, as if at some time I had been accustomed to hear and to use them. I had experienced nothing at all similar with the French and German languages, which I had begun to learn about a year before, and which had always seemed to me radically strange. There was nothing to account for this odd fact. No Spaniard, or person who had visited Spain, had come in my way. Being given to prying, I sought to ascertain whether my early infancy had been partly spent in Spain, but I soon got convincing evidence that I could never have been 20 miles away from the place where I was then living. I dismissed the question as beyond my reach; but about twenty years afterwards I learnt, quite accidentally, that my mother's father had passed his childhood in the neighbourhood of Malaga, and that the Spanish was his first language." This seems to us a fair instance of hereditary reminiscence.

The author observes that when old friends meet and talk over bye-gone days, there is "a gradual re-instatement of seemingly lost experiences which often partakes of a semi-voluntary process

* *See* H. G. Duvergier, in the Victorian Review, March 1, 1880.

of self-delusion." It seems to us that such revivals are by no means always conducive to accurate remembrance. Among a group of men who have been fellow-witnesses of, or co-participants in, events, and especially if they have been in the habit of dwelling thereon, the process of what may be called mythogenesis is very active. Instance a regimental mess, the members of a hunt, the professors of a college, &c. The joint memories of such knots of men, without any intention or consciousness of exaggeration or distortion on their part, are often full of illusions.

The memory of an event may often undergo a very rapid decomposition in the mind of a single witness, unless he reduces them to writing at an early stage. Suppose that we have witnessed some striking occurrence, not admitting in its description of any strict numerical details. Some time after it strikes us that the affair will have a particular interest for some friend. We are apt to relate it to him in imagination, and to lay a predominating weight on those phases of the matter with which he will be most struck. What we then remember will not be the occurrence itself, but our version of it, and if some time passes before we have an opportunity of telling or writing it illusions will creep in.

Mr. Sully considers that what we call recollection is uniformly a process of softening the reality. It is remarkable how little the vividness of an impression is kept up, even by the most distinct recollection of all the attendant circumstances. We may, for instance, be able to summon up every minutest detail of the death-scene of some friend, but the sorrow is only a far-off echo.

We should have been glad to notice the remaining portions of this book, and some at least of the many interesting side-issues that are raised.

The author very justly remarks:—"There seems to me no reason why an animal endowed with fine olfactory sensibility, and capable of an analytical separation of sense-elements, should not gain a rough perception of an external order much more complete than our auditory perception, which is necessarily so fragmentary."

"Spiritualist *séances*" are several times referred to in the work as hot-beds of illusion. This may be so; but we fear that the "exposers" and opponents of spiritualism might in like manner serve as an instance of equal and opposite illusions.

Electric Meteorology. An Endeavour to show the General Agency of Electricity in the Cause of Rain and its Allied Phenomena, with an Appeal for the Consideration of the Theory advanced. By G. A. Rowell. Oxford: Slatter and Rose.

This work, though small in compass, contains much matter worthy of careful consideration. The author is a heretic in science, for he considers electricity not as a modification of energy, but as a substantive entity,—in short, an "imponderable," capable of occupying space, but having a buoyant power or a minus weight. It is attracted by bodies in proportion to their temperature. The dryness of high-pressure steam and its harmlessness on coming in contact with the skin are ascribed to the particles being kept apart by coatings of electricity.

A similar explanation is given of the effects of "superheated metals," as in the experiments of Leidenfrost, Boutigny, &c. The author quotes and rejects the theories of Boutigny and Tyndall.

Fog, Mr. Rowell explains as being "composed of particles of water, each enveloped in a coating of electricity in the proportion of 860 to 1, together with atmospheric air in an inverse ratio to the density of the fog."

The cause of rain he pronounces to be vapour having lost the electricity by which it was previously supported. He believes that an upward stroke of lightning from the earth to the clouds is an impossibility. The agency of trees, especially conifers, in increasing rain and in preventing hail, seem to speak on behalf of some portion of Mr. Rowell's theory. Prof. Rolleston, in a lecture delivered May 12th, 1879, quotes certain observations of M. Becquerel on the effects of the destruction of forests as being in favour of Mr. Rowell's views.

We beg to bespeak for this little pamphlet the careful attention of meteorological observers. The only persons who can fairly criticise Mr. Rowell are those who have the opportunity of regularly studying and recording the changes of the weather. That our received meteorological notions are exceedingly imperfect is generally admitted.

The Glacial Beds of the Clyde and Forth. By T. Mellard Reade, C.E., F.G.S. Liverpool: Tinling and Co.

This memoir is a reprint from the Proceedings of the Liverpool Geological Society. The conviction has forced itself upon the author that there has been a tendency to unnecessarily complicate these Glacial phenomena,—to raise every gravel bed into a

"formation," or bed of sand into a "period," while "inter-glacial episodes are profusely scattered through the whole, apparently with the sole object of finding what Mr. Croll says must have happened."

Mr. Reade cannot accept the theory that the Till is wholly subaërial, and formed under land ice. It seems to him "most unphilosophical first of all to attribute the planeing, grooving, smoothing, and striating of the whole surface of the land to ice, and then to make the very same agent, without any apparent reason for the change, deposit a mass of Till in the same places, sometimes reaching 162 feet thick."

Essay on the Artificial Propagation of Anadromous Fish other than the Salmon, and the Re-stocking the Tidal Waters of our Large Rivers artificially with Smelts.

Prize Essay, National Fisheries Exhibition, Norwich, 1881, *on the Utilisation of Localities in Norfolk and Suffolk suitable for the Cultivation of Mussels and other Shell-fish.* By C. W. Harding, Assoc. Inst. C.E. King's Lynn: Thew and Son.

These two essays, courteously forwarded us by the author, are valuable contributions to the good work so ably conducted by the late Frank Buckland.

We must, in the first place, enter our protest against the word "anadromous" as a piece of utterly gratuitous classicalism. Its exact English translation, "up running," would answer the same purpose, and would be more easily remembered by that large majority of the public (including multitudes of naturalists) who have either never learnt Greek, or who, like ourselves, have had to throw it overboard to make room for more important matter.

Mr. Harding announces the important conclusion that "whenever the tidal river fisheries have been more or less exhausted, the sea-fish proper, which at certain seasons of the year approach the coast, have fallen off in equal ratio." From the information to which we have access we have little doubt but that this view is correct.

The author's plea for the enactment of a close time for all fishes, and for in general preventing fishermen, in their short-sighted greediness, from killing the goose which lays the golden eggs, is just and proper. Alternate periods of glut and scarcity, in any trade, are bad for producer and consumer, and good only for monopolist middlemen. Most of all is this the case with a perishable article such as fish.

The author points to the very decided success of artificial, systematic pisciculture in America. Exhausted rivers have been re-stocked and brought back to their original state, and the public, who were at first apathetic and ignorant, have now come to take an intelligent interest in fish-preservation. Why cannot equally satisfactory results be reached here?

Among the enemies of the oyster-fisheries the author mentions the star-fish and the dog-whelk. Of the former he had last year to remove between 200 and 300 tons to prevent the bed being entirely destroyed. He has known a mussel-bed of 10 acres destroyed by these depredators in a fortnight.

The Progress of Science. Vol. I., No. 1. May, 1881. Boston: 45, Pearl Street, Boston, U.S.

We have here the first number of a new scientific organ, which, according to an editorial notice, is to be "devoted as far as practicable to original investigations; bold researches after rational truths, whether in fashion or out of fashion; well-considered speculations indicating the direction of future scientific conquests, and hints, more or less full, as to the probable means by which the intimated results may be obtained."

The articles in this first number are—An Essay on Social Science, which scarcely lies within our legitimate scope; a notice of the New Mode of Forcing Plants; a paper, singularly fallacious as it seems to us, by J. B. Dimblely, on "A Line of Astronomical Time from the Eclipses;" two articles on "Aërial Navigation," an enterprise to which we cannot wish well, believing that it will give a fearful advantage to aggressive war; "The Limits of Science," by President D. W. Fisher; "Bottled Daylight," by Eric Stuart Bruce; the commencement of a series of papers, by F. R. Condor, C.E., under the title "What the World now asks from the Inventor;" "The Perihelia," a memoir in which E. C. Carrigan ably exposes the alarmist predictions of some great calamity to happen during the current year, in consequence of the relative positions of the planets. "Godless Science" is an extract from the "New Jerusalem Magazine."

Observations on Mount Etna. By S. P. Langley.

This memoir is a reprint from the "American Journal of Science," and treats on the atmospheric characteristices of Mount Etna as a site for an observatory. He finds that, at the altitude of the Casa del Bosco (4200 feet), stars of two-thirds the brightness of those seen in England with the like telescopic power can be distinguished. The gain on Etna, as compared with a lower station, is more in clearness of the atmosphere than in freedom from tremor. In solar work he distinguishes two classes of phenomena. In those of the photosphere, whether seen directly by the telescope or recorded by photography, an optical tranquillity of the atmosphere is of more importance than transparency. On the other hand, for spectroscopic researches and for investigations of the sun's radiant heat, transparency is essential.

During a few days' stay in Egypt the definition of the sky was almost unequalled. From his own experience, joined to that of M. Janssen in the Himalayas, he concludes that the mere fact of a high elevation by no means ensures good vision, though the chances are better at a considerable altitude, other things being equal.

Report on Insects Injurious to Sugar-Cane. By J. H. Comstock. Washington: Government Printing-Office.

The species here described are *Ligyrus ruficeps*, a lamellicorn beetle of the evil family of the cockchafers (Melolonthidæ). The insect is about ½ an inch in length, and in the larval state bores into the stem of the cane beneath the surface of the ground. If sugar-cane is deficient it destroys maize.

The "sugar-cane borer," *Diatræ sacchari*, is a moth belonging to the Pyralidæ. It also, in case of need, extends its ravages to corn. The damage done by these two species, hitherto almost overlooked, is very serious. The general public can form, as yet, not the remotest idea of the percentage of agricultural produce destroyed by insects.

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

ANIMISM *versus* HYLOZOISM.

To the Editor of The Journal of Science.

Sir,—Every lover of truth and of fair play must admit that "Audi alteram partem" is a most legitimate plea, even though the views advanced under it should seem somewhat wild and extravagant, provided they are urged with some show of reason, and with due respect for the honest and cherished convictions of opponents. I have therefore no reason to complain of the author of the article which bears the high-sounding title of "Hylozoistic Materialism," whom I must suppose to be a Monist of the most pronounced type, calling in question the equally decided Dualistic views expressed in my articles on "Life and its Basis." Nor will he, I am sure, object to my testing the weight and measure of *his* arguments.

Passing by the marvellous title given to this new species of Materialism (the meaning of which even a Greek scholar would not find it very easy to understand), I must request attention to the assertion at the outset, that the views afterwards stated are "a logical deduction from the fundamental principles of Science and Theology." This last point the writer aims to prove by another assertion, viz., that the hypothesis of an Omnipresent Deity destroys "all distinction between body and soul, between God and the world." This may be C. N.'s theology, but it is not mine, nor that of the Bible. It is a simple paradox.

Observe next the *naive* confession, that while every child and every savage is an unconscious Materialist, the grandest and most mature intellects that ever adorned human science and philosophy are almost without exception arrayed *against* this theory. Moreover, I entirely demur to the correctness of the premiss, that every simple healthy human being is an unconscious Materialist. The reverse is notoriously the case, even on his own showing, or he would not have to lament over the antagonism displayed, by "learned and ignorant alike," to his theorem. I

would suggest that men's having, in the first instance, to deal with, and derive their ideas from, material things, by no means prevents their recognition of "higher entities," both in themselves and their fellow-creatures, in after life.

At p. 314 the writer specifies two of the chief antagonists to his views as being the belief in, or rather the difficulty of denying, the existence of an immaterial principle, or soul; and that matter is, in its essence, *inert*. It is plain, then, that *Hylozoism* denies, while *Animism* maintains, the existence of immaterial entities; and that while Animism considers matter, *per se*, to be inert, this Materialism endows it with essential activity. Let us take the latter thesis first. It asserts that matter is essentially active, because in a great many cases our senses do not reveal the direct cause of its motions. It appears (in the case, for example, of a falling body) to move of itself. But will C. N. contend that nothing has a real existence but that which is cognisable by our senses? Then he must give up his belief in the existence of almost every force in Nature,—*e.g.*, magnetism or electricity, for he cannot see them; indeed he cannot *see* the force in his own arm, he can only *infer* it from its visible effects; *or*, from a conscious feeling in his mind that he possesses it. For the very fact of our consciousness that we can, at will, exert force upon matter, proves that there is something in our bodies superior to matter, and therefore necessarily distinct from, however associated with, matter. But in the same page we are told, in a quotation from Dr. Lewins, that "the *anima mundi* and the *anima humana* are, at bottom, one and the same." Then the soul of man does exist after all, only it is one with the *anima mundi*. Whatever may be meant by this term, it cannot but be an entity and a unity; and the *anima* of each man must be a part of that unity. There is one trifling objection to this notion —that it is inconsistent with personal individuality; and that C. N. and myself might just as well (as far as our *animæ* are concerned) be called the same person—a point somewhat doubtful.

But further:—neither C. N. nor Dr. Lewins actually deny the existence of a Supreme Intelligence or Eternal Mind; they are good enough to allow that such a Being may possibly exist;—though we must call them Agnostics on this point. Must not, then, this Being be the *Anima mundi*? They admit, however, that there *is* something besides matter in the Universe; unless they are prepared to adopt the only logical conclusion of their speculations, viz., that God and man alike are nothing but *matter* —a position which would be an edifying illustration of the insinuation against Christian Theists in the last paragraph on p. 318, that "man creates a God after his own image."

But if there is an Infinite Mind, who can deny to it the power of giving existence to *finite* minds, call them souls or spirits, or what we will? At any rate, the admission is fatal to the doctrine

of Materialism as here stated. Nor is this all. What is the Energy, or *vis incita*, which is put forward, at p. 314 and elsewhere, as a generalisation of the Newtonian force of Gravitation, and inseparable from every particle of matter? Energy means working power, but this of necessity implies a being who *works* and exerts the power: and as the energy is everywhere, at one and the same time, the Worker must be everywhere, at all times. This energy is manifested universally, not only in Gravitation, but in Light, Heat, and perhaps other of the imponderables; for they seem to be all forms of motion in matter,—and where the work is going on, there the Worker must be. In ascribing, therefore, all these natural results to Energy, Hylozoism virtually supposes a Being acting on or *in* matter; and what is this but Dualism?

On p. 315 C. N. asserts that this inherent activity of matter renders a belief in "creative acts" superfluous and absurd, and removes the distinction between life and death (!), both of which are diverse manifestations of the same energy. Be it so; but I have shown above that this Energy is virtually a synonym for the Being whom *we* recognise as God. And this is exactly what Dualistic philosophy affirms.

But this leads me to revert to a statement made in p. 313, that "Science cannot logically assume *two* causes where one is sufficient. It is C. N.'s logic that is at fault here; for there are two manifest fallacies in this short sentence. Does he deny what is called a *chain* of causation? or the fact of one (so-called) cause depending, like a link, on an antecedent cause? In this sense Science is bound to assume two, or perhaps several causes. Again, what is meant by a cause being *sufficient*? If the cause alluded to is force or energy as an abstract notion, *independent* of a living agent, I entirely deny its sufficiency; for it has no real existence as an entity.

One word on the extraordinary assertion on p. 315, that "if we cannot deny the existence of the soul, neither can we deny that of fairies, goblins, &c., or the reality of witchcraft." This is a very rash inference; for the worst and most absurd errors are often the corruptions or exaggerations of truths. And I decline to allow that truth is reponsible for the errors engrafted upon it by popular ignorance, or attempted to be fastened on it by its opponents, whether intentionally or otherwise.

A little further on C. N. quotes my remark that plants are not possessed of moral faculties, and turns aside the force of it by allowing its truth, and then assuming that I was speaking not of the whole plant, but of the inorganic atoms of which they are built up; observing that there is nothing to show that they will ever become a sentient organism. And he proceeds to compare this with certain well-known chemical changes which produce, from the same elements, compounds of the most opposite character and properties. But who imagines that in these latter

cases there is "the entrance or exit of an *invisible entity*"? *I* do not; and if I predicate such an entity in animals* it is because they furnish evidence of volition, which cannot be reasonably ascribed to mere matter. But I must again remind C. N. that the *energy* to which he attributes chemical, as well as vital, processes, must in reason have a cause, and that a Mighty and Intelligent Cause.

There is yet another fallacy to be noticed, in p. 316. Animal life is asserted to be a mere chemical process, *because* it is maintained by several chemical operations, and "waxes or wanes" with their energy. This, however, though in reality but partially true, merely shows that vital *bodily* powers have been made, to a great extent, dependent upon these wondrous processes, and wholly fails to prove that they are identical with vitality. C. N.'s conclusion is far wider than his premisses.

In p. 317 he asserts—in opposition to my hypothesis—that cellular vitality is identical with that of the conscious brain. This may be quite true. But the brain is not the *whole* of the living organism; it is only *one* of its organs. And the fact, admitted, by no means *disposes* of the distinction he alludes to, because the *anima* is connected, more or less, with every part of the body, especially with the other vital organs, and with the blood and nerves. I beg to add that I *do* regard sensation as belonging to (not proceeding from) the nervous tissue; but perception of that sensation as belonging to the living *anima* associated with it, exclusively.

C. N. imagines a great difficulty in the way of the dualist (in the last paragraph of this page). But the difficulty vanishes in the light of the admitted fact, that the higher faculties of the soul have been made dependent (but only in our present state) upon the health and integrity of its corporeal organs, and more especially of the brain.

In conclusion, and in reply to C. N.'s protest against my assumption that the "initiation of life in non-living matter is the action of a higher power," I would ask, Is not the *energy* to which C. N. attributes it an unseen power? if we call it the *vis insita*, or "implanted force," in Nature; I ask, *Whose* force? and who implanted it? I am thoroughly convinced of the futility of the attempt to eliminate the constant, universal presence of an Almighty and All-wise Being from the material "Cosmos." Yet this is *not* Pantheism, ancient or modern; for matter is the production of God, and therefore not God himself. This Eternal, Self-existent Being is the JEHOVAH of Holy Scripture, who says

* In reference to a remark made by C. N., in p. 317, "that the consistent dualist must believe that an *anima* resides in the lowest animals," I have no doubt that this is so. But I also believe that the variety in the scale of these *animæ* is as great as that of their material organisms; and that the desired length of their individual existence is equally various, ranging from a few minutes to a virtual eternity.

of himself "I am the first, and I am the last, and beside me there is no God" (Is. xliv., 6). Being omnipresent, He can and has revealed himself to his rational creatures "at sundry times and in divers manners." And one of these manners is Nature—that wonderful Cosmos of which C. N. truly says that it is "an indivisible unity;" and this, I would add, because its Author and Sustainer is "the one living and pure God."—I am, &c.,

J. H. B.

PS.—In reference to the note at the foot of p. 317, I beg to refer the writer to the note appended to my second article in p. 81 of your February number.

BURDENSOME NEOLOGISMS.

To the Editor of the Journal of Science.

Sir,—Having heard with pleasure the enlightened views enunciated by Prof. Huxley at the opening of the Mason College, Birmingham, I was somewhat surprised to find him, in an otherwise valuable paper ("Proceedings of the Zoological Society," 1880, Part IV., p. 649), manufacturing new technical terms which must be quite unintelligible to all who are not Greek scholars. Hypicthyes, myzichthyes, chondrichthyes, herpetichthyes, hypotheria, prototheria, metatheria, and eutheria are no trifling addition to the terminology with which biological science is encumbered. It is to little purpose to found colleges in which classical studies are set aside if such studies are made imperative by reason of the Greek technical terms which are becoming from year to year more numerous and more long-winded.—I am, &c.,

Common Sense.

ADVICE GRATIS IN HIGH PLACES.

To the Editor of the Journal of Science.

Sir,—Has it ever struck you as something peculiar that in this country government departments always consider themselves entitled to gratuitous scientific advice? Suppose that, for instance, some new vegetable disease has broken out in any part of Her Majesty's dominions, or some insect pest has made its

appearance, forthwith a Secretary of State writes to one of our learned societies to obtain their opinion. As a general rule a special committee is appointed to consider the evidence on the question, always voluminous and generally unscientific. Microscopic examinations have to be made, and a very considerable expenditure of time and trouble is demanded. Now were our learned societies, like those of some foreign countries, subsidised by the State, all this would be quite natural; but it is somewhat singular in case of societies which are entirely self-supported.—I am, &c.,

AMPHIOXUS.

ANIMAL CANNIBALISM.

To the Editor of the Journal of Science.

SIR,—Allow me to give your correspondent "Scrutator" a further instance of animal cannibalism. According to Jerdon's "Mammals of India" (p. 94) a wounded tiger has been observed to be dragged away and partly devoured by one of its own species. The male guinea-pig not unfrequently combines cannibalism and infanticide by preying upon his own offspring.—I am, &c.,

A. D. B.

NOTES.

The following remarks, taken from the letter of Sir Henry Marsh on the proof "Report of the Committee of the Faculty of Medicine of the London University, have a much wider value than the writer more immediately intended, and apply to other than medical examinations, whether "final" or otherwise:—"My next proposition," he says, "should be to have annual examinations on fixed, definite, and limited subjects, and these necessary ones, and no large final, and as it now is, boundless examinations. I think this *grand* examination most pernicious in its effect on the student's mind, and ill-calculated to effect its intended object—that of being a test of proficiency. The object now before a student's mind is to be well prepared for this great and dreaded examination, and not, as it should be, to know and treat disease. The student's proficiency should also be ascertained step by step. This would be best ascertained by yearly or half-yearly examinations. Here with us this great examination, on which a young man thinks his prospects and success for life depend, is most injurious to the mind and the whole course of study. Its wide range gives a hopelessness as to being fully prepared, and the health of many has been permanently impaired. The pupils are at the mercy of the examiners, some of whom, it uniformly happens, are blockheads. Time and health are wasted in useless studies to prepare, not for practice of one's profession, but to answer either book questions or fanciful and often absurd ones. Those who are most flippant, and least disturbed by *mauvaise honte*, are, I have found in many instances, the best answerers, but the really worst informed. Grinding and cramming thrive; no one ventures on this awful examination without bringing grist to the mills of the grinders."

M. Clémandot ("Comptes Rendus") contends that the phosphorescence of bodies is due to a vibration excited chiefly by the blue ray of light.

M. E. L. Trouessart, in a communication to the Academy of Sciences, treats of the agency of marine currents in the geographical distribution of amphibious mammals. He concludes that the Otariidæ have originated in the Antarctic regions, and have branched out towards the north, occupying the shores of Patagonia, the Falklands, South Africa, New Zealand, and Australia. Humboldt's current has carried them to the west of South America as far as the Gallopagos, but no farther. Those found on the Californian coast belong to different genera, and have

arrived by the route of West Australia, the Chinese and Japanese seas, Kamtschatka, the Aleutians and Alaska, arriving finally at California from the northwards.

The Irish College of Physicians have, curiously enough, petitioned Parliament that medical practitioners should no longer be permitted to become coroners. Dr. Lyons, M.P., has refused to present it.

A so-called "Anti-Vivisection Conference" took place at Edinburgh on May 21st, under the presidence of General Grant. A paper bearing the inappropriate name of "Fact," some little time ago, expressed its satisfaction that so many naval and military officers were joining in the anti-vivisection hubbub, and stated that this conduct was the result of their "bravery." We should trace it, if true, to their ignorance of the real merits of the question—an ignorance of which "Honorary Secretaries" have not been slow to take advantage.

Prof. Calderwood, in a lecture recently delivered at Glasgow, declared that anatomical structure was not in itself a trustworthy guide in determining comparative position in the scale of organic existence, and that even comparative brain-structure could not be accepted as the sole standard of the measure of intelligence. He quoted Sir John Lubbock as declaring that, though the anthropoid apes ranked next to man in bodily structure, the ants must claim the second place in intelligence. He considered that the order of ants offered exceptional difficulties for the theory of evolution, and also for the theory of intelligence as a function of brain structure.

MM. Arloing, Cornovin, and Thomas, in consequence of the success of their experiments on inoculation for splenic fever, have applied their method on 295 cattle, and will report the result at the end of the season.

There has been found at Solana de Langostura, in the province of Segovia, the entrance to a cavern containing a number of human skeletons, mixed with flint tools and coarse pottery, some of it ornamented with very primitive designs. The perfect skulls have been sent to Madrid.

According to the "Journal of the Royal Archæological Association of Ireland," ragmen are the chief friends of the collector of antiquities.

The same journal gives an account of a genuine jade celt, discovered at Ahoghill, County Antrim. It is the only specimen of the kind hitherto discovered in Ireland, or, with the exception of one found in Cornwall, in the whole of the United Kingdom.

The same journal reprints a short tract, of the date 1679, giving an account of certain strange phenomena seen in the air at

Poins-Town, Tipperary, and seemingly belonging to the same class as the *fata morgana*.

An insecticide plant, a *Botrytis*, has been observed in the hot-houses of the Botanical Garden of Montpellier. It has rapidly destroyed a number of Aphides of the genus *Siphonophora*, the remains of which are covered with the mycelium of the fungus.

We learn that the Prince of Wales, Lord Haughton, and Dean Liddell have been elected Trustees of the British Museum. We think that, *e.g.*, Lord Walsingham would have been much more suitable than either of the two latter.

According to the "Echo"—"At length a small modicum of authentic information has leaked out as to the doings of the Committee on Solar Physics at South Kensington. From consecutive statements made at the meeting of the Royal Astronomical Society by Mr. Lockyer and Mr. W. H. Christie, on the evening of the 13th ult., it would appear that this secretly-appointed company has been engaged in making observations which for some time past have been as well, or better, made at the Royal Observatory at Greenwich!"

Two new eyeless snails have been discovered in the underground waters of Carriola.

The funeral of M. Littré, the "positivist" leader, gave rise to a decided tumult."

The "Inventor's Record" states that "a spiritualist is going to bring out a book called 'The Occult World,' based on his experience in the East." The work in question contains the express declaration that "occult phenomena must not be confounded with the phenomena of Spiritualism," and the author even states "It is not my present task to make war on Spiritualism."

Sir John Lubbock finds that ants are sensitive to the ultra-violet rays, and carefully carry away their larvæ from under its influence. (We have long ago been led to the opinion that insects enjoy a different, and probably wider, range of vision than do vertebrate animals.

A popular journal gives the following alarming prescription for the treatment of gnat-bites:—"Alcohol, 1 part; crystallised carbolic acid, 9 parts!"

A "Field Club," with botanical, geological, and entomological sections, has been organised at Buffalo.

According to special investigations, conducted at the Smithsonian Institution, the green colour observed in certain oysters is due not to the presence of copper, but to certain green Algæ upon which the oyster feeds eagerly.

M. Pasteur has shown that the seat of the poison of rabies is not in the saliva alone; it is present in the brain, and with at least equal virulence.

"Mr. Cumberland" is about to publish a book explaining the methods used by mediums to produce spiritual manifestations.

M. A. Béchamp, in reply to a recent paper by M. Pasteur in the "Comptes Rendus," maintains the existence of *Microzyma cretæ*, by the action of which he has obtained alcohol, acetic, lactic, and butyric acids.

M. Richet has laid before the Academy of Sciences a paper on the movements of the frog consecutive on electric excitation.

Dr. Ayres ("New York Medical Journal") thinks it idle to look for a picture of the surroundings on the retina of a person who has met with a violent death.

According to the "Chemiker Zeitung" Profs. Kolbe and E. von Meyer have detected two spurious inaugural dissertations put forward by A. O. Lütkemeyer and A. Weinberg. Both are simply copies of pre-existing documents.

Since 1864 Mauritius has been stripped of its forests, and its fertility and salubrity have alike suffered. The hills are now being re-planted.

"La Nature" wisely cautions naturalists to complete the study of the larger Mammalia, birds, and reptiles, before their certain extirpation.

We learn from the "Popular Science Monthly" that the students of Harvard University have been formally canvassed as to their religious opinions! This reminds us of a certain "declaration" that was got up some years ago, and sent round for signature among the Fellows of our learned societies.

Dr. Hureau de Villeneuve has come forward as the President of the Vegetarian Society of Paris. Like many of his fellow "dietetic reformers" in England, he tolerates the use of eggs, milk, butter, and cheese, which certain American enthusiasts reject as "putrid curd."

We regret to learn that Mr. Shelford Bidwell's paper on "Telegraphic Photography," to have been read before the Society of Arts on May 26th, has been postponed owing to the severe indisposition of the author.

The British Association has not yet summoned up the courage necessary for the amputation of its "economic section"—a much-needed operation.

M. G. de Saporta, in a communication to the Academy of Sciences, expresses doubts as to the supposed occurrence of the Proteaceæ in the European fossil flora.

According to M. A. Gaudry the Permian reptiles of France diminish the vast interval which exists at present between the reptiles and the monotrematous mammals.

The ferment which M. Béchamp supposed he had discovered in chalk has been traced, by MM. Chamberland and Roux, to an experimental error.

According to M. Tayon the production of wool in sheep is inversely as the secretion of milk.

The "Chemiker Zeitung" states that all the English and French professors at the University of Yeddo, Japan, have been dismissed, and their places filled with Germans. The Japanese Minister of Public Instruction is a German professor. The Chinese are about establishing a German University at Pekin. These facts should be duly weighed by those who still doubt the superiority of German research over English cram and examinations!

J. Starkie Gardner ("Geological Magazine") re-discusses the question of the permanence of continents and sea-depths. He considers that though the greatest depths of the ocean may have always been permanent, the banks and ridges, with islands occasionally rising to the surface and crossing the Atlantic or Pacific, must be either rising or sinking.

Mr. C. S. Wilkinson, New South Wales Government Geologist, has discovered glacial boulders in secondary deposits, near Sidney.

The working naturalists of Des Moines have organised a so-called "Agassiz Field Club."

The larvæ of certain Bombyliidæ—so-called bee-flies—prey eagerly on the eggs of the dreaded American locust, *Caloptenus spretus*.

Lord Walsingham enumerates forty-eight species of Tortricidæ common to Europe and the Pacific coast of North America.

A reprint of the compendium of the natural sciences, written in the ninth century by Rhaban Maurus, and used for a long time as a text-book at the College of Fulda, has recently appeared. It includes astronomy, geography, anthropology, and theoretic medicine, and in all these departments it ignores all facts not to be found in the writers of classical antiquity.

Dr. Hermann Mueller deals a crushing reply to Bonnier's supposed refutation of the inter-relation of flowers and insects.

There are suspicions that the *Phylloxera* has found its way to the vineyards of Victoria.

The larva of a Coleopterous insect, supposed to be that of a *Lytta*, is found to destroy the eggs of the locust in the Troad.

It is known to most of our readers that a medal has recently been struck in honour of M. Milne-Edwards, the opponent of Evolutionism. The "Revue des Sciences Biologiques" gives a very clever article called "The Reverse of the Medal," which may be profitably read by the friends of "official science" on this side the Channel. The sterile and retrograde condition of French biology is due to his influence, which has been exerted with an omnipotence which no *savant* ever before possessed in any country. He has imprisoned zoology in the narrow ideas of Cuvier; he has energetically and patiently combatted all progress, repressed merit, and sought by all means to isolate the youth of France from the great scientific movement going on in neighbouring nations.

M. Pauchon has made a series of experiments with beans, on the influence of the colour of seeds on germination. He finds, in order to reach the same visible stage of development, a black or violet seed absorbs more oxygen than a white or yellow one, though a more rapid germination is observed in the latter. On the other hand, the quantities of carbonic acid exhaled by white seeds are found to be greater than those from the dark, sometimes even double. These differences are considered to prove that dark or violet seeds are better conditioned from a physiological point of view. In the natural state, *i.e.*, when the seeds germinate in light, the conversion of legumin into asparagin must go on much more easily in the coloured seeds than in the others. "The more frequent and pronounced pigmentation of seeds of northern lands is, therefore," says M. Pauchon, "a favourable circumstance for the growth of these organisms, under the peculiar light conditions to which they are subject."

Lord Walsingham, in a paper read before the Entomological Society, gave several instances of Micro-Lepidoptera found in South Africa, and identical with, or at least closely allied to, forms supposed peculiar to South America.

The question as to whether the larvæ of moths ever breed in the horns and hoofs of living animals is still undecided.

According to H. von Koppenfels ("American Naturalist") mongrels between the male gorilla (*Troglodytes gorilla*) and the female chimpanzee (*T. niger*) occasionally occur in the Gaboon district. Du Chaillu's Kooloo-Kamba, N'schigo, M'bouve, &c., are only names given to the chimpanzee by different tribes.

The *Cervus maral*, of Western Siberia, exists in a state of domestication among the Cossacks near Kiakhta.

Dr. S. V. Clevenger ("Science," May 28) supports, in opposition to Prov. Mivart, the view of Mr. H. Spencer, that instinct is a higher development of reason.

Mr. A. H. Swinton, who is favourably known to many of our readers from his work on "Insect Variety," writes as follows to "Science":—"It may concern some of your readers to know that I have just made the interesting discovery that the multiplication and migration of the rocky mountain locust [*Caloptenus spretus*] has been hitherto in exact agreement with the minima of Wolf's sun-spot cycles as given in the "Mem. Astr. Soc." (vols. xlii. and xliii.), and its decrease has as nearly accorded with the maxima, there not being a year's difference. On European areas insect migration but rarely agrees with these maxima and minima, the chief periods being obtained by counting the elevens since 1846. It would be important to determine the multiplication of corn-weevils in relation to the sun-spots. Cannot the trade keep diaries? As the more destructive kind comes from the tropics, the minimum period should be dreaded."

Lasaulx ("Mineralog. Mittheil." n. s., vol. iii., p. 517), after a careful examination, pronounces the inorganic portion of the atmospheric dust to be of purely terrestrial, and not cosmic, origin.

According to Dr. C. Meineret the proportion of nitrogen excreted without assimilation is, in meat and eggs, 2·6 per cent; in milk, 7; in maccaroni, 17·1; in peas, 27·8; in lentils, 40·2; in white wheat bread, 19·9; and in brown bread, 42·3 per cent. Hence it appears that a much larger proportion of the nutriment is utilised in case of animal than of vegetable food. How do the vegetarians propose to deal with this consideration?

It has been decided in Paris that there can be no binding agreement between a patient and his doctor, the former not being regarded as a free agent.

It is considered probable that Palenque was already deserted and in ruins at the time of the Spanish conquest of Mexico.

Mr. F. A. Ober, after a careful examination of the ornithology of the Carribbee Islands, finds that each group has one or more species peculiar to itself. He has discovered about twenty birds new to Science.

We are glad to learn, from communications received, that the new Technological and Industrial Museum at Sydney will include a department of economic entomology, the specimens being so arranged as to enable the public to discriminate between insects injurious to man and such as work for his benefit. The insects will be shown in all stages of growth, and along with them specimens of the materials spoiled or injured. Where actual specimens cannot be exhibited, the career of the insects will be illustrated by models and diagrams.

"*The Lancet*" *on Competitive Examination.*—The competitive system, as applied to youths, has produced a most ruinous effect on the mental constitution which this generation has to hand down to the next, and particularly the next-but-one ensuing. Schoolwork should be purely and exclusively directed to development. "Cramming" the young for examination purposes is like compelling an infant in arms to sit up before the muscles of its back are strong enough to support it in the upright position, or to sustain the weight of its body on its legs by standing, while as yet the limbs are unable to bear the burden imposed on them. Another blunder is committed when one of the organs of the body—to wit, the brain—is worked at the expense of other parts of the organism, in face of the fact that the measure of general health is proportioned to the integrity of development and the functional activity of the body as a whole in the harmony of its component systems. No one organ can be developed at the expense of the rest without a corresponding weakening of the whole. These faults of "training" attain their supreme height of folly and shortsightedness when they are committed in reference to the youths destined for the public services. The work of the Civil Service Commissioners in respect of these classes is individually and racially destructive. Sooner or later public opinion must recognise this fact, and then perhaps the Legislature may be moved to intervene—not before, but when it is too late. (In fact, for the sake of securing one moderately efficient young man for the public service, some five or six, including the successful candidate, are injured for life! It is impossible to avoid invoking a solemn curse on the originator of this scheme.)

Prof. E. Ray Lankester on Competitive Examination.—We are mistaken—indeed very seriously mistaken—in supposing that competition for places can do much to raise the standard of scientific work. Good patient work, due to the free workings of genius, and that unconscious aptitude and insight which belong to it, is not fostered, but actually forbidden,—starved at the roots by the wear and tear of competition.

ERRATA.

Page 364, line 13 from bottom, *for* "all volcanoes are on the top of mountains" *read* "nearly all," &c.

Page 363, line 6 from bottom, *for* "48·250" *read* "48250."

NINETEENTH YEAR OF PUBLICATION.

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THE

JOURNAL OF SCIENCE.

AUGUST, 1881.

I. THE CENTRE OF GRAVITY OF THE EARTH, AND ITS EFFECT ON ASTRONOMICAL OBSERVATIONS.

By Col. A. W. Drayson, R.A., F.R.A.S.

ANY novelty brought forward in the present day ought deservedly to be submitted to every form of fair criticism, in order that its truth or falsity may be tested. To assume that we have arrived at the end of discovery is, it will be generally admitted by reasonable men, a mistake; whilst to refuse to investigate, or even examine, any original problem, is a proceeding similar to that which retarded the advancement of Science in the Dark Ages.

During some considerable time I have endeavoured to make known through the usual channels the facts which I herein bring to notice, but from circumstances over which I have no control my endeavour has been thwarted. As, however, the facts remain, I believe it possible that many enquirers may be found who will be interested in, and may follow out, the proofs which I here submit to them.

At the present time it is assumed that the Earth is an oblate spheroid; that the Equator divides the Earth into hemispheres; that the two Poles of the Earth are equidistant from all parts of the Equator; that the axis of the Earth passes through the centre of the circle termed the Equator; that the zenith of all localities on the Earth is that point found by drawing an imaginary line from the centre of the Earth through the locality, and producing this line to the sphere of the Heavens; and that the various

zeniths correspond to the radii of a circle drawn from the centre of this circle or sphere.

On the accuracy, or otherwise, of these assumptions depend the correctness, or otherwise, of some important details in practical Astronomy.

An investigation of any terrestrial globe reveals the fact that, in the Northern Hemisphere of the Earth, the mass of land above the sea exceeds considerably the mass of land in the Southern Hemisphere that is above the sea. In the Northern Hemisphere, above the sea is the whole of Asia, Europe, and North America, two-thirds of Africa, and a small portion of South America. To balance, as we may term it, this amount of land in the Northern Hemisphere, there is in the Southern Hemisphere one-third of Africa, the island of Australia, and the greater portion of South America. The fact exists, therefore, that there is in the Northern Hemisphere at least twice the quantity of land above the ocean that there is in the Southern Hemisphere.

Now it does not alter the conditions or laws which will be referred to, even though the Earth be a perfect sphere instead of a spheroid. But it must follow that the surface of the ocean in corresponding latitudes, north and south, must be at the same distance from the Earth's centre; thus the surface of the ocean in, say, 10° S. latitude is at the same distance from the Earth's centre as the surface of the ocean in 10° N. latitude, and so on for each corresponding degree of latitude north and south of the Equator. It follows, therefore, that if the Equator be equidistant at all parts from the Poles of the Earth, the preponderance of land in the Northern Hemisphere must cause *the centre of gravity of the Earth to be located north of this Equator.*

Again, the distribution of land above the sea in the Northern Hemisphere is so arranged that the preponderance is located between about 15° W. longitude from Greenwich and 120° E. longitude, and a meridian of about 15° E. longitude passes over the greatest amount of land. It would follow, therefore, that if the Poles of the Earth be equidistant from all parts of the Equator, the axis of the Earth cannot pass through the centre of gravity of the Earth. If the axis of the Earth does pass through the centre of gravity of the Earth, then the poles of this axis cannot be equidistant from all parts of the Equator.

From a long series of investigations I have come to the conclusion that the centre of gravity of the Earth is located 1115 feet north of the Equator, and 2100 feet distant from

an axis, joining the two poles. A meridian of 15° E. longitude passes through this centre of gravity.

Before entering into a description of the results which follow, it must be pointed out that if the North and South Poles of the Earth be equidistant from all parts of the Equator, it must be a most marvellous coincidence if the axis of the Earth passes through the centre of gravity of the Earth, because the land and water on the Earth's surface are most unequally distributed. If the axis of the Earth does pass through the centre of gravity of the Earth, then the Poles cannot be equidistant from all parts of the Equator.

It may appear, at first sight, to those persons unacquainted with practical astronomy and geometry, that so small a divergence as 1115 feet for the position of the centre of gravity of the Earth from the Earth's centre would not affect, in a perceptible manner, any astronomical observations. The effects, however, would be most singular and most marked.

The zenith of any locality on Earth (from which zenith measurements are made to determine the zenith distance of stars, and hence their declinations) is obtained by means of a trough of mercury, or a plumb-line; whichever method was adopted the results would be the same, and for simplicity of explanation I will select the plumb-line.

The plumb-line at any locality would be directed *to the centre of gravity of the Earth, and not to the true centre of the sphere,* and this law would hold good for every locality on Earth. The zenith of each locality, therefore, would be assigned a position in the Heavens found by drawing a line from the centre of gravity of the Earth through each locality, and producing this to the sphere of the Heavens. The results of this fact are most singular, and a few of these will now be demonstrated.

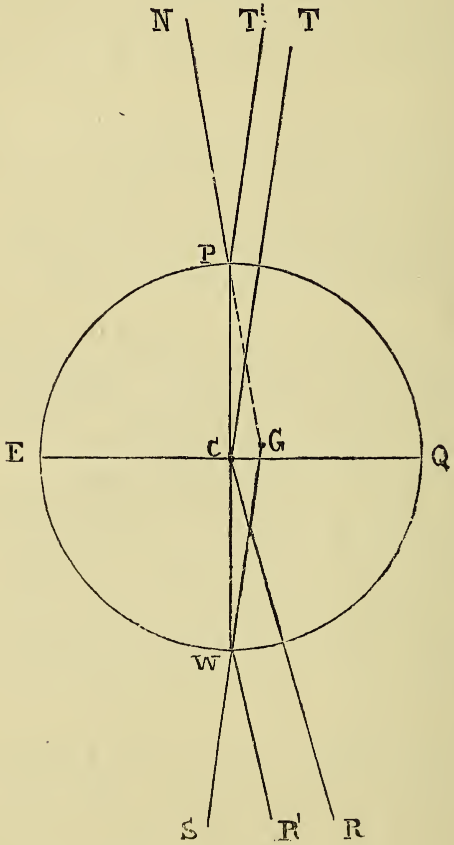
I will first suppose two observers to be located one at each Pole, and using a transit instrument. The Poles being supposed equidistant from all parts of the Equator, each observer ascertains the position of his zenith by means of a plumb-line or trough of mercury, and then determines the zenith distance of certain stars. Each observer being at a Pole of the Earth, zenith distances and polar distances would be supposed identical, and the effects on the supposed polar distances of stars can now be demonstrated.

E P Q W represents a section of the Earth through the Poles C W; C the centre of the Earth; G the centre of gravity of the Earth.

2 G 2

C T and C R the direction of two stars, the sum of whose declinations equal the angle T C R. The declination of the star T would be obtained by subtracting its polar distance from 90°, and the declination of the star R obtained in the same manner.

DIAGRAM I.



The observer at the North Pole, P, would find his zenith in the direction of G P produced, G being the centre of gravity of the Earth, whereas the true zenith of P would be in the direction of C P produced. From P draw P T′ parallel to C T, and the zenith distance of the star T would, by observation at the pole P, be N P T′. Consequently this zenith or polar distance would by observation be too great by the amount of

the angle C P G, which angle is the divergence produced on the plumb-line at the pole P, in consequence of the centre of gravity of the Earth not coinciding with the Earth's centre. In like manner, at the opposite pole W, a star R would be assigned a polar and zenith distance, S W R′, which polar distance would be too great by the amount of the angle C W G, which angle is the amount of divergence of the plumb-line, at the pole W, due to the centre of gravity of the Earth not being coincident with the Earth's centre. The declination, consequently, of the two stars T and R, derived from these observed zenith distances, would be too small by the amount of the angles C P G, C W G.

I will now suppose that an interval of six months elapsed, and the two stars, T and R, were again observed when the Earth had moved round 180° of its orbit; half a rotation of the earth having occurred in addition to the rotations due to six months.

The centre of gravity (G) of the Earth would, in consequence of half a rotation of the Earth, be located on the opposite side of the axis to that on which it was located six months previously; consequently the zenith at the Poles would be directed towards a point in the Heavens different from that point towards which it was directed six months previously.

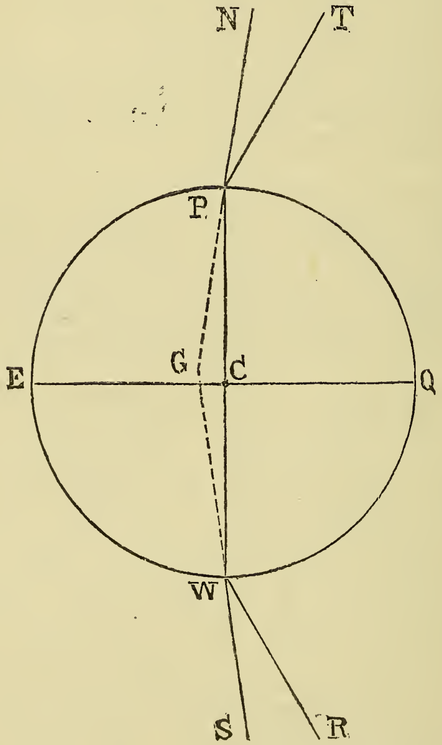
The following diagram (2) will demonstrate this fact.

As before, the points P and W represent the North and South Poles; E C Q the Equator; C the centre of the Earth; G the centre of gravity; P T the direction of the North Star; W R the direction of the South Star. A line from G through P will give, if produced, the direction P N for the zenith of P; and a line from G through W will give, if produced, the direction W S for the zenith of W. Consequently the observed zenith distance of the star T will be less from this observation than it was six months previously by twice the angle G P C; and the zenith distance of the star R, observed from W, will be also less than it was on the previous occasion by twice the angle G W C. But zenith distances at the pole are also polar distances, and consequently the assigned polar distances of the stars T and R would be less by twice the angle G P C when observed at the two intervals. If these two stars, having say eighteen hours' right ascension, the one a North Polar star, the other a South Polar star,—were observed at 6 a.m. in March, and again at 6 p.m. in September, the assigned polar distances of these stars would be found to differ considerably at the two dates, and consequently the sum of their declinations would be found

to differ considerably at intervals of six months, and from no other cause than that the centre of gravity of the Earth does dot coincide with the true centre of the Earth. The amount in minutes and seconds of arc due to this position of the centre of gravity of the Earth can now be demonstrated.

From an investigation of the relative arrangement of land and water on the surface of the Earth, I have concluded

DIAGRAM 2.



that the centre of gravity of the Earth is 2100 feet from the axis joining the two poles, which two poles are equidistant from all parts of the Equator. A second of latitude may be taken as equal to 101 feet on the Earth's surface; consequently 2100 feet may be taken as about 20″·7. It follows, therefore, that a plumb-line at the Poles directed towards the centre of gravity of the Earth would form an angle of 20″·7 with an axis joining the two poles. Consequently the

angle G P C in Diagram 2 would be 20″·7, and this 20″·7 is the amount that the polar distance of a star would be in error if seen from the Pole; and twice 20″·7, that is 41″·4, would be the difference in polar distance of a star found by two observations at intervals of six months. As this error would be nearly the same at both poles, it would be found that two stars near each pole would, when the sum of their declinations was taken at intervals of six months, differ to the amount of about 82″.

The question now arises whether any such differences have been found between any two stars when the sum of the declinations is taken; and observations prove that this fact exists, and has long been known, though a very different theory has been invented to account for the facts; it having been assumed, on no evidence whatever, and in spite of the facts shown by the unequal distribution of land and water on the Earth's surface, that the axis of the Earth passes exactly through the centre of gravity of the Earth, and that the poles of this axis are equidistant from all parts of the Equator.

I will take, for example, the two stars 4 Draconis and β Chamæleontis, whose declinations are given in the "Nautical Almanac of England and America." These two stars are nearly on the same meridian of right ascension, and their declinations have been found as follows:—

4 Draconis	78° 16′ 30″·4 N.,	Jan. 1, 1880.
β Chamæleontis ...	78° 38′ 33″·7 S.;	Jan. 18.
Sum	156° 55′ 4″·1	

In June these declinations are as follows:—

4 Draconis	78° 17′ 1″·2 N.
β Chamæleontis	78° 39′ 22″·5 S.
Sum	156° 56′ 23″·7
	156° 55′ 4″·1
Difference	1′ 19″·6 = 79″·6.

Or exactly the result which would occur in consequence of the centre of gravity of the Earth not coinciding with the Earth's centre.

Again, take the two stars Polaris and α Eridani, and, adopting the same principle, a difference of 75″ is found in

the sum of the declinations of these two stars between January and June of the same year.

Again, take the two stars σ Octantis and δ Ursæ Majoris, and compare the sum of the declinations of these two stars on March 30th and September 30th, 1880, and these will be found as follows:—

σ Octantis	89° 16′ 12″·7 S.,	March 30.
δ Ursæ Majoris ...	86° 36′ 11″·7 N.,	„
Sum	175° 52′ 24″·4	
σ Octantis	89° 16′ 47″·1	Sept. 30.
δ Ursæ Majoris ...	86° 36′ 51″·7	„
Sum	175° 53′ 38″·8	
	52′ 24″·4	
Difference... ...	1′ 14″·4 = 74″·4.	

It thus appears that those differences actually occur in observations which must occur in consequence of the centre of gravity of the Earth not coinciding with the Earth's centre, causing a divergence in the zenith of certain localities, in consequence of the plumb-line being directed to the centre of gravity of the sphere, and not the true centre.

An examination of the Diagrams 1 and 2 will show that the great difference between the observed zenith distances of stars will occur at or near the pole, and when stars can be seen both above and below the pole. If a star can be seen only above the pole, the changes in zenith distance or declination, due to the position of the centre of gravity of the Earth, will be but slight. For example, supposing an observer at Q, Diagram 1, the zenith of this observer would be found by the production of the line joining G and Q, but a star near the zenith of Q could only be seen when the centre of gravity (G) occupied the same, or nearly the same, position that is shown in Diagram 1. Consequently the observed change in zenith distance of a star near the Equator, due to the position of the centre of gravity of the Earth, will be very slight, whereas the change in zenith distance of a star near the poles will be very great, as shown by Diagrams 1 and 2. Hence the greatest changes found annually in the declination of stars will be in circumpolar stars.

If the axis of diurnal rotation of the Earth were always parallel to itself, the zenith of an observer at the poles would

describe a circle during one rotation. The zenith of other localities would describe ellipses, which ellipses would show a greater difference between the major and minor axis the nearer they approached the Equator, until at or near the Equator the zenith would trace a straight line, equal in length to the major axis of the ellipse.

As, however, the axis of the earth changes its direction annually, to the amount of about 20″·25, towards or nearly towards the first point of Aries, the circle becomes a curve, which I have named the Nautilus curve. If it be a fact that the position of the centre of gravity of the Earth produces the apparent changes in the zenith distance of the stars, it will be possible, by aid of this Nautilus curve, to measure the amount of change in declination of any star near the poles, and also to show where the right ascension of *any* star will change, and how this change will vary during each month of the year. Such a demonstration must, I think, carry with it a proof of its accuracy.

(To be continued.)

II. GEOLOGY AS A SCIENCE AND AN ART.*

By C. Lloyd Morgan.

OF the several questions which my subject involves I give precedence to the very general one, "What is Science?" Now-a-days we hear not a little of science, of scientific culture, and of scientific discoveries. But I have no doubt that, if we were to ask a number of people of average education to set down a definition of science, many of them would be puzzled what point or points to pick out, by which to distinguish scientific knowledge from other kinds of knowledge. And I think that not a few of them might be driven to writing down a list of the several branches of science, and stating that science has to do with chemistry, geology, natural history, metallurgy, &c., &c. That is to say, they would define science by its subject matter. But we hear now-a-days of the science of history, the science of language, even the science of religion, while the science of sociology claims as its domain all the

* Read before the South African Philosophical Society in Cape Town.

facts which are connected with the social relations of human beings. I do not think, then, we can thus define science by a reference to its subject matter, since science now claims as its subject matter the whole realm of fact.

Etymologically science is knowledge; but we can hardly say that, as we now use the words, all knowledge is science. Let us suppose that an English schoolboy spends most of his holidays at the Zoological Gardens. At the end of four or five weeks he may know the names—perhaps even the Latin names—of a great number of the animals, and may have learnt also something of their habits. Now such knowledge, *as long as it consists merely of isolated facts*, is not science. But if he be an intelligent boy he *will* learn some science in his four or five weeks at the Zoological Gardens, for he will perceive that the animals are not placed in different cages *hap-hazard*. He will notice that some are grouped together, as the flesh-eaters or Carnivora; others, as the Rodents or gnawers; others, as the Ungulates or hoofed animals. If once the boy grasps this, his knowledge is no longer one of isolated facts, but a knowledge of grouped facts. This grouping of the facts is an essential element in Science. And much as a zoologist's knowledge differs from our supposed schoolboy's in extent, or number of facts known, it differs far more in the orderly grouping of the facts, in the perception of connection among the facts, and in the power of seeing their relations. In a word Science is organised knowledge, while mere general information is unorganised. This, then, is one of the important elements in Science. A second and equally important element is its exactness. Ordinary knowledge is indefinite and vague; Science is, or should be, definite and precise. For ordinary knowledge it is sufficient to say that all heavy bodies fall to the earth, while light bodies rise; but for Science this will not do, and since the time of Newton we must state the matter precisely, taking into consideration the mass of the attracting and attracted bodies and their distance asunder. For ordinary knowledge it is sufficient to divide plants into herbs, shrubs, and trees; but for Science the classification of the vegetable kingdom must be based on more exact principles. For ordinary knowledge, once more, it is sufficient to divide the higher animals into birds, beasts, and fishes; Science, however, makes use of more exact means of distinction than is afforded by the element in which animals live. And in some respects Science even reverses our ordinary rough-and-ready classification. It tells us, for example, that a whale, though it live in the sea, is not a

fish, but a beast; and that a bat, though it fly in the air, is a beast, and not a bird. For the whale and the bat agree with the higher beasts, or Mammalia, in the important characteristic of suckling their young. If, therefore, I were asked to pick out the two most distinctive features of Science, I should take *organisation and exactness.*

In further illustration of this, compare our ordinary knowledge of the heavenly bodies with that formulated by Astronomy. To the ordinary observer the sun shines by day, and by night the moon rises and sets, has her periods and her phases; Venus or Jupiter is now the first among the stars to appear in the evening, and now the last to be lost in the more powerful light of day; Saturn and Mars may be seen from time to time; Orion's belt, Cassiopeia, the Great Bear, and a few other constellations, are well-known groups; for the rest the heavens are more or less a maze. To the astronomer, on the other hand, every planet is but a unit in a *definite system;* of that unit the periods of revolution round the sun, of rotation on its axis, the figure, mass, and path, the motions of its attendant satellites, perhaps, and a dozen other facts are *accurately* known. The sun is not only our source of light, but the ruler of a system and the originator of nearly all available forms of energy on the earth's surface: he is not fixed in space, but drifting in a known direction and with a calculated velocity: he is not merely a ball of fire, but a body of wonderfully complex physical constitution and of ascertainable chemical composition. Nothing in fact can better illustrate the gradual advance in the organisation and exactness of scientific knowledge than the history of astronomy in general, and of the solar system in especial.

In organisation and exactness, then, I repeat, lies the essence of Science; or, to use another metaphor, scientific knowledge is *crystallised knowledge,* as opposed to the comparatively formless or amorphous mass which constitutes general information. What, then, is the aim of Science? Clearly to crystallise our knowledge; clearly to give ordinary knowledge that organisation and exactness which it lacks. And the aim of the several divisions of science, or sciences as we call them, is to develop a consistent body of crystallised knowledge, which we may call doctrine, concerning the particular groups of natural facts with which they severally deal.

And now let us see whether the various branches of science are all of one kind; for if they be not, then we shall have to note presently to which kind Geology belongs. If we

take a steam-engine, and try and find out the laws of its working, we shall, I think, find that there are three kinds of science involved. In the first place we may study its mode of working as a whole; that is to say, we may regard the steam-engine as a complicated mass of mutually dependent parts, and find out all we can about the working of these several parts under ordinary conditions, and as tending to the working of the engine as a whole. That is one way of studying it. Then, secondly, we may pay special attention to certain definite parts of the engine, and ascertain how they work, not under ordinary conditions, but under simpler conditions when distracting influences have been removed or allowed for. For example, we know the pressure of the steam and all the other conditions of its action on the piston, and we find out how rapidly this would propel the engine *if there were no such thing as friction.* This kind of science, it will be seen, differs from the first; its generalisations deal, if I may so say, not with things as they *are*, but with things as they *might be.* But for all that it aids us immensely in the study of things as they are. Thirdly, we may express numerically and calculate mathematically the rates of working of various parts of the engine, or the relative number of revolutions which the larger and smaller wheels make in the same time; that is to say, we may apply certain mathematical laws of relation to certain facts connected with our engine. But these laws of relation, which are worked out by the third kind of science, are altogether abstract, and have no necessary connection with the wheels or their revolutions, any more than with reapers and fields, or steamers and sailing ships, with the vast distances of stars or the minute masses of molecules, or any other problems to which they may be applied. The third kind of science is of no practical use by itself, but of enormous practical use in its application.

Of this third kind of science, to which Mathematics and Logic belong, I need say nothing here. Of the second class Physics and Chemistry are examples. Take as an instance of a scientific law of this class the well-known first law of motion,—that a moving body if left to itself would continue its motion for an indefinite time in the same direction and with the same velocity. But no real body that we know anything about *is* "left to itself." So that this is, if I may again be allowed the expression, a law of things as they might be, not of things as they are. Take, again, the law of pressures,—that the volume of a gas varies inversely as the pressure put upon it. Not only does that law require

careful allowance to be made for any variations in temperature, but, so far as I know, it does not strictly hold good in the case of any single known gas. At great pressures all gases show deviations from this law; but this is only because they are not under all conditions *perfect gases*. For a perfect gas, could such be found, the law would hold good for all pressures. Coming now to the first class of science (in the order in which I have enumerated them), we may take Zoology, or the natural history of animals, as an example. Naturalists study the animal world as they find it; and Mr. Darwin's law of Natural Selection has for its object to formulate how varieties and species *are* being formed under the conditions of our Earth, not how they would be evolved if those conditions were different. Botany, Sociology, Astronomy (at least under one of its aspects), and our special subject Geology, also come under this class of science.

Now all these three kinds of science are mutually helpful to each other; and now-a-days sciences of the first class, such as Geology, cannot get on at all without the aid of such sciences as Physics and Chemistry, which belong to the second class. Nor can the sciences of the second class get on at all without the aid of the sciences of the third class, Mathematics and Logic.

The next question is, Are these three kinds of science equally exact? To this I answer, No, they are not. The third, with Mathematics for its type, is by far the most exact. Pure mathematics is, indeed, the type of exactness and definiteness. Then comes Physics, the most exact science of the second class. Physics we may say is quite exact, wherever we may be sure of isolating its problems and getting rid of, or allowing for, all disturbing elements. Then it can apply mathematical processes with perfect confidence. But when we come to problems belonging to the first class of science, to the study of phenomena *as wholes*, then we cannot and must not expect the same exactness. This is not because the phenomena are not subject to law, for all phenomena whatsoever are subject to law, but because the conditions are so complicated, and there are such a number of influences at work, that the human mind is inadequate completely to unravel them. Even in Astronomy, where the conditions are by far more easily unravelled than in any other concrete science, the theory of the moon is still an unsolved problem.

I dwell on this distinction between these three kinds of science, partly because I believe the distinction to be in itself

very important, and partly because I want to make it clear that we cannot expect mathematical exactness in such a science as Geology, which it must be remembered belongs to our first class. In Geology, in fact, and in the allied sciences, the advance of our knowledge has, perhaps, been greater in the direction of organisation than in that of exactness. And with respect to this increased organisation it may be noticed that not only have geologists been able to class their stratified deposits, according to their mode of origin, into rocks formed by (1) mechanical agency, (2) by chemical agency, and (3) by vital agency; not only have they ascertained the order of the sequence of the strata; not only have they begun to grasp the definite succession of life-forms; but they have traced the shading of the stratified deposits into metamorphic rocks, these again into plutonic rocks of the granitic type, and these once more into rocks of volcanic origin.

But though geological knowledge is, compared to Mathematics, inexact, it does nevertheless become more exact, as any one may see who will take the trouble to compare our present knowledge with that of half a century ago; but we must not expect mathematical exactness. As we shall see directly, Geology is an historical science; it deals with the past. And if we cannot apply mathematical processes with success to the more complicated of the phenomena of to-day, the conditions of which are actually present, still less can we apply them to the past, when the conditions have to be inferred.

There is a well-known controversy between geologists and physicists, in which the distinction between the two kinds of science should be steadily borne in mind. The discussion is on the question of geological time. The physicist says to the geologist "The earth's crust solidified and cooled so many years ago," and brings forward in proof certain definite figures obtained by mathematical processes. "Geologists," he says, "must confine their speculations to this period." The geologist answers, "I can't bring forward figures, but that period is not nearly long enough." There the matter rests to-day, and, doctors differing, the general public does not know what to think. But I fancy that the potency of figures inclines them to the view of the physicist. Now the point to which I wish to draw attention is this—that it is the business of the student of physics, dealing as he does with a science of our second class, to isolate certain facts by excluding or allowing for all interfering causes. He considers each of the factors of phenomena separately; he

is accustomed, too, to be able to determine the data for the application of mathematical processes to his problems with great accuracy; so that in his own department his conclusions have a value that none can dispute. But suppose that he takes up such a problem as geological time, the difficulties of disentangling the factors of the phenomena and the difficulties of determining accurate data are so great that his conclusions cannot be said to possess anything like the same value. Let me, however, quote the words of Dr. Whewell, who, as both a mathematician and an historian of science, was peculiarly fitted to offer an opinion:—"A mature consideration of the subject," he says, "will make us hesitate to ascribe much value to the labours of those writers who have applied mathematical reasoning to geological questions. Such reasoning, when it is carried to the extent which requires symbolical processes, has always been, I conceive, a source not of knowledge, but of error and confusion; for in such applications the real questions are slurred over in the hypothetical assumptions of the mathematician, while the calculation misleads its followers by a false aspect of demonstration."

Now the geology of to-day cannot, as I have said, get on at all without the aid of chemistry and physics. For all aid which she receives from the cultivators of these sciences she is heartily thankful. But she does not like to have figures, evolved perhaps on insufficient data, crammed down her throat, nor does she like the tone of the remark "Geologists must confine their speculations to this period."

Leaving this point, let me now proceed to ask another question—"Is there a clear distinction between a Science and an Art; and, if so, of what nature is that distinction? I believe that there is a definite distinction. The object and aim of Science is, as I believe, to establish a body of organised, and as far as possible exact, knowledge: the object and aim of Art is to *apply* the knowledge thus gained to *practical ends*. I think this is a distinction which aids us much in getting clear ideas, and I shall therefore illustrate it by an example. It is the object of the science of Chemistry to ascertain the laws which regulate the combinations and recombinations of the several elements of which all the various substances with which we come in daily contact, of which everything, in fact, that is found in the crust of the earth, is composed. In the course of his work the chemist has to group these various elements, and to separate them one from the other. This he does as a scientific man, in order to gain knowledge. But he may not improbably come to the

conclusion that pure science does not pay; that is not at all an unlikely conclusion for him to come to, and he may therefore make it his profession to apply his knowledge to practical ends. He may become an *assayer*, and connecting himself, say, with the Cape Copper Company, may determine for them the amount of copper and other materials in their ores. Now I call assaying an Art, not a Science, and I think the assayer should be considered a professional man, not a man of science; for the man of science applies his knowledge to the widening the boundaries of our knowledge, or making our existing knowledge more completely organised or more rigidly exact, not immediately to the practical ends of every-day life. In the same way the navigator, the land-surveyor, the engineer, the medical practitioner are men who have to learn some of the facts and principles established by Science, for the sake of their professional work; but unless they are extending the boundaries of our knowledge, or contributing to the organisation of that knowledge, they are not men of science, in what I believe to be the true sense of the term. Nevertheless they will be successful in so far as they employ the method of science: that method is *to proceed by observation and experiment, by guarded hypothesis and careful verification from the known to the unknown, on the well-founded assumption of the uniformity of Nature.* Let me give you an example of the application of this method. The lead obtained from certain English and other ores contains a varying quantity of silver, often several ounces to the ton. Up to the year 1833, however, no method was known by which lead, containing less than 8 ounces of silver to the ton, could be desilverised. Thus not only was a large quantity of valuable metal lost, but the lead itself was rendered by the silver harder, and therefore for certain purposes less valuable. In 1833, Mr. H. L. Pattinson, among others, was endeavouring to solve this problem of the separation of these two metals, and it chanced that he dropped a crucible containing molten lead rich in silver. Such an accident might happen a hundred times and nothing come of it. But Mr. Pattinson's keen eye detected crystalline grains in the spilt metal, and he carefully picked some of them out for special examination. I do not know what thoughts were in his mind when he did so, but he may not improbably have said to himself something of this sort:—"When sea-water freezes the ice formed is comparatively free from salt, while the water remaining is comparatively rich in salt; it may be that these solid grains are comparatively free from silver, while the lead remaining is comparatively rich in silver." If he argued thus

he formed for himself an hypothesis. At all events he set to work and carefully analysed the crystals, and found as an actual fact that they *were* nearly pure lead. Taking for granted, then, the uniformity of Nature, Pattinson saw that what had taken place by an accident in his laboratory could be reproduced of set purpose on a large scale in a metallurgical process; and by the process he thus devised, which is called after him Pattinson's process, thousands of tons of lead are now being treated every year. This discovery of Pattinson's affords us, as it seems to me, a good example of the employment of the scientific method.

And, now, after so long an introduction, an introduction, however, not unnecessary, I come to my more immediate subject—Geology as a Science and an Art. First, what is its aim as a science? Secondly, what arts depend upon the body of doctrine which it establishes? As a science geology occupies rather a peculiar position. If we separate it from that which is now called physiography, but which is also called the science of physical geography, it becomes a purely historical science. Hence it has been said that geology is the physical geography of the past, and physical geography is the geology of the present. To understand what geology is, then, we must understand what physical geography is. Unfortunately physical geography, as set forth in many of the older text-books not yet out of use, is a queer jumble of fragmentary information. We all know the celebrated definition of a man of culture as one who knows something about everything and everything about something. I think the books on physical geography, of which I speak, may be defined as containing a little about everything and everything about nothing. But if we take physical geography in the relation to geology above indicated, we must define it as the science which treats of those causes now in operation, which modify the crust of the earth. Then geology becomes the application of the knowledge thus gained to the past history of the earth under the altered conditions indicated by a study of such portions of the earth's crust as come within our reach. For such study mineralogy and petrology afford some of the requisite data.

There is another branch of science which, in one of its aspects, is an integral part of geology, and, in another of its aspects, is a portion of the science of biology. I refer to Palæontology. Palæontology is the study of ancient life forms. It gives facts concerning the creatures which once lived on the earth's surface, which facts may be interpreted

on the principles of biology. Just as mineralogy and petrology give facts concerning the minerals and rocks which are buried in the earth's crust, which facts may be interpreted on the principles of physical geography.

Now, if we turn to Sir Charles Lyell's master work on geology, first published more than fifty years ago, we shall find that its title runs as follows: "Principles of Geology; or, the Modern Changes of the Earth and its Inhabitants Considered as Illustrative of Geology" (11th edition). In that book, therefore, and it is still and will long continue a standard work, we may say that the Science of Geology is, by implication, defined as the ancient physical and life history of the earth. The physical history is based on the application of our knowledge of those causes now in operation, which modify the crust of the earth elaborated by the science of physical geography. The life history is based on the application of our knowledge of the facts of animal and vegetable life elaborated by biology. This is the widest definition of geology. But from what I have said it will, I think, be seen that it is quite impossible to circumscribe a definite area of knowledge, and say, this is geology and nothing but geology. I have, therefore, prepared a table showing the manner in which geology is related to her sister sciences.

MATHEMATICS AND LOGIC.

CHEMISTRY AND PHYSICS.

Mineralogy and Petrology. (for facts.)	Physical Geography. (for principles).	Biology. (for principles.)	Palæontology. (for facts.)
PHYSICAL.		GEOLOGY.	PALÆONTOLOGICAL.

In that table are shown the two sub-divisions of geology, the one dependent on mineralogy and petrology for facts and physical geography for principles, the other dependent on palæontology for facts and biology for principles. Chemistry and physics, which are placed above, deal with the isolated factors, of which the problems of the sciences below are the complex products; while mathematics and logic, which are placed at the top, deal with the relations which may be established between the facts or phenomena supplied by the underlying sciences.

With the principles of all the branches of science, which are included in that table, the geologist should be acquainted. Of course I do not mean to say that he should attempt to keep abreast of all these branches of science. On the con-

trary, if he is to advance our knowledge of the subject he must pick out a small plot of the wide field of geological science, and rather spend his time in cultivating that thoroughly, than in wandering up and down that and adjoining fields, and doing a bit here and a bit there. If he be a man of genius he may in time be promoted to be an overseer. But it requires very exceptional powers to be a geological philosopher like Sir Charles Lyell, not only surveying but organising the whole field of geological science.

I may here, perhaps, be allowed to say a few words concerning the value of geology in education. In the University of the Cape of Good Hope, chemistry and geology are alternative subjects for matriculation. We may, I think, take it for granted that the vast majority of candidates are acquainted with no other branch of science, except of course the mathematics. Refer now to the table above. A text-book on geology deals more or less fully according to its scope, with all the branches of science set down on that table, except, of course, formal logic. A text-book on chemistry, on the other hand, deals with its own subject matter alone, *plus* some applied mathematics, and some physics, the first principles of which are generally so clearly explained that this is a clear gain. I leave you to judge which is the best for a candidate to take up. Wherever it is possible I should advise the student, who wants to gain some scientific culture, to study an example of each of the three kinds of science, say mathematics, physics or chemistry, and geology or natural history. From each a distinct kind of training is acquired; from the first, accuracy of thought and exactness; from the second, the application of exact methods of actual facts encountered experimentally, under conditions fairly within control; from the third, comprehensiveness, power of observation, and the invaluable habit of taking all the facts into consideration to the exclusion of none. If, however, he has only time to take up two branches, let them by all means be mathematics and physics or chemistry. With these as a foundation he will be able at any time to take up and make rapid progress in such a science as geology.

Leaving "Geology as a Science," let us now turn to "Geology as an art." [Here followed examples (1) of the loss of money which has so frequently been the result of sinking for coal in subcarboniferous rocks, in wilful ignorance of geological results, or even in spite of the warnings of geologists; and (2) of the practical good that has come of

the enlightened application of theoretical knowledge of geology, as in the case of the Artesian well at Grenelle, near Paris.]

As an art, then, geology has done great service to mankind, and in doing so she has profited as a science. Such a well as that of Grenelle, near Paris, would never have been sunk without the aid of the geologist. But in sinking such a well new facts are learnt and new inferences drawn, which may be built up into the fabric of geological doctrine. This is always the case when science and art work hand in hand. To take one other example among many, science gives to the world the art of telegraphy; and when telegraphy is established, science can fix with an accuracy otherwise impossible the longitude of such a place as the Observatory of the Cape of Good Hope, and thus add to the accuracy of her doctrine.

I now pass on to illustrate the methods and results of geological inquiry. I have said that geology is an historical science. The question therefore arises, How are we to solve such problems as the mode of origin of the rocks, seeing that they were formed in the remote past ? There is an old method and a new, an unscientific method and a scientific. The old method was to sit in your study and *think the matter out*. Let me give you the results of one or two of these thinkings. One thinker—it is hardly necessary to mention the names of these excellent folk—one thinker imagined that the crust of the earth was fissured by the sun's rays, and thus the diluvial waters were let loose from a supposed central abyss, and from these waters the rocks—they are estimated to be about fourteen miles thick in England—were deposited in a few days. Another attributed everything to the tail of a comet, with which the earth was fortunate or unfortunate enough to come in contact. A third set down the formation of all the strata to the heaping up of materials thrown out by volcanoes. Then, again, with regard to the fossilised remains of organic beings. One said they were sports of nature, very like real shells indeed, but due to the influence of the stars or to fermentation. Another followed Theophrastes, the pupil of Aristotle, in saying that the fish had gone astray out of the rivers, and so—how much lies hid in that "and so"—and so got petrified. While a third maintained that the fossil shells on high mountains had fallen from the hats of holy pilgrims. We laugh at these idle speculations. But it is rather the futility of the method than its results that we should deride. I, for one, have no wish to disparage honest studious thought, but

I *do* wish to point out the necessity of balancing honest thought with a due weight of honest fact.

That, then, is the old method; what is the new? The answer to this question contains the golden rule of geology. *Read the riddle of the past by the light of the facts of to-day.* [The rest of the paper consisted of a description of ice-action in the past as illustrated by a careful study of the ice-action of to-day.]

III. THE SOURCE OF ELECTRIC ENERGY.

By Charles Morris.

(Continued from page 391.)

WHERE a charged conductor acts upon an uncharged body the same law is obeyed. If the conductor be positively charged it affects the molecules of the other body, the adjacent poles becoming negatively, the remote poles positively, charged. This primary action is followed by a secondary action of conduction and neutralisation between the poles of anterior molecules, and only the charge of the surface molecules persists, this being negative on the adjacent surface and positive on the remote surface. If, now, this remote surface be connected with the earth its charge disappears, the effect being simply an immense increase of surface. On this connection being again broken, the conductor remains in the apparently anomalous condition of possessing a negative charge on one surface and being destitute of charge elsewhere. It might be imagined that a new induction would take place through the neutral body, with a reproduction of its former state; but the fact is that, through the loss of the positive induced force, the negative induced force has become negative charge. The case has become changed from that of a positively charged body acting upon an uncharged, to that of a positive acting upon a negative charge. And this negative charge is just sufficient to balance the induction of the positive body. The inductive action continues, but the positive induced energy of the remote surface is exactly balanced by the negative

charge, so that this surface remains electrically neutral, and only the negative charge on the adjacent surface is apparent. On increasing the distance between the bodies the inductive effect diminishes, and negative electricity appears on the whole surface. On diminishing the distance the inductive effect increases, and positive electricity reappears on the remote surface.

This view of the case dispenses with the usual idea that positive repels positive, and attracts negative, and *vice versa.* Each conductor simply acts towards the other as it would upon an uncharged conductor. If the first be positive and the second negative, the first exerts an inductive influence upon the second, causing negative force to appear on the neighbouring, and positive on the remote, pole. This new force is added to or subtracted from the previously existing negative of the second, so that this energy is augmented on one surface and decreased on the other. The second body exerts a like influence, in the opposite direction, upon the first. In the case of both being positive, or both negative, the rule is the same. Each acts on the other as on an uncharged body. The charge on each has added to it an induced charge, which weakens it in one direction and strengthens it in the other. There is no real attraction of unlike and repulsion of like electricities, though the result gives that impression. In the interior of a charged conductor a similar rule holds good. If one surface be plane and the other concave internally, the lines of induction from the concave to the plane surface are divergent, those from the plane to the concave are convergent. Thus the inductive effect upon any portion of the concave surface exceeds that upon an equal area of the plane surface. The charge on any area of the concave surface is augmented, that on an equal area of the plane surface decreased, by this difference in inductive action. Thus the surface charge of a conductor varies in amount in strict conformity to the shape of the surface of the conductor.

The conclusions thus arrived at lead to another probable conclusion, at which we have already glanced. In a charged conductor the primary effect of neutralisation of the internal molecular charge would be to confine the effective electricity to the outwardly directed poles of the surface molecules. But the neutralisation of the opposite charge on the inwardly directed poles of these molecules must render this restriction impossible. The electric disturbance necessarily flows back and affects the molecule as a whole. Instead of its having a normal heat and two opposite abnormal atomic

vibrations, it has a normal heat and an abnormal electric vibration, whose pitch is either above or below that of the heat, according as the charge is positive or negative. Thus there is a surface layer of electrically charged molecules, acting inductively in both directions, inward and outward. Its outward inductions are effective; its inward are ineffective, except in the case of an irregularly shaped body, in which the inductive effect, through the body, on equal areas of the surface, differs in vigour.

The principle considered in the above argument is undoubtedly a universal principle of Nature, and one which arises from the necessary relations of the molecular condition of matter. Electric disturbance is not necessary to its action. Any discordance in the motive relations of molecules is sufficient to produce its effects. Every molecule disturbs the motive conditions of every other not actually homogeneous with it. There is a constant resistance to heterogeneity, and a constant effort to produce homogeneity, in the motive conditions of the molecules of all substances. But this effort is partly balanced by a counter effort in each substance to retain its normal molecular condition. Thus between the effort to produce conformity and the effort to resist change there is a constant struggle. The latter is usually the stronger when the bodies are separated; but when they are brought into contact the former may often prevail, even if there is no difference in their motive vigours, if we may judge by the apparent results of contact electricity. When there is a difference in vigour, whether this results from heat, from friction, or from chemical change, the effort to produce conformity usually, perhaps always, overcomes, with the production of the various electrical phenomena. Every molecule whose vibratory relations are disturbed causes a similar disturbance, gradually decreasing with distance, in the vibratory relations of surrounding molecules. Every molecule having a different vibratory period from that of any other seeks to produce conformity to its own condition in this other, and the disturbance may become measurable if they be in contact. Wherever the vibratory energy of the one exceeds that of the other, the disturbance is followed by a flow of energy, if resistance to this flow be not too declared. The principle is that every molecule strives to preserve its normal motive conditions, and if these be disturbed to restore them, either inwardly or by the aid of a like disturbance of the motive conditions of neighbouring molecules, and an outward neutralisation of the disturbed vibratory energy. These molecules, in their

turn, resist disturbance to their normal conditions, and there is thus a struggle between two opposed energies, of which the strongest must conquer. If restoration of normal conditions be produced inwardly, no result appears; if outwardly, a flow of electric force is the apparent result.

In the case of a conductor of galvanic electricity the conditions are really similar to those existing in static conductors. The flow of the current is here preceded by an inductive action in both directions, whose result is the appearance of free positive electricity on one pole and negative on the other. This inductive action rapidly increases as the energy of chemical action becomes more declared. Finally, the polarisation is so vigorous as to overcome the resistance of the dielectric medium, and the two electricities become neutralised in this medium, with the production of a concentrated local energy by their combination, vigorous enough to yield heat and light. Or if the resistance be too great for this, particles are torn bodily off from the poles, and conveyed across the intervening space, the energy which they carry becoming partly converted into heat in the passage.

The electric current here produced is not confined to solid conductors. It also passes through liquids,—either that concerned in the chemical action, or other liquids introduced at intervals in the current. And its passage through these liquids is accomplished in a mode which it is usual to consider as peculiar, and essentially different from its method of passage through solids. If, however, the hypothesis which I have here presented is a correct one, the method of electric conduction is the same in all cases, and there is nothing peculiar in electrolytic conduction. The electrolyte is made up of compound molecules. Conduction in it is undoubtedly preceded by induction, as elsewhere. The motive relations of its molecules are disturbed, one of the constituents of the compound becoming positive, the other negative. If, as in static electricity, the influencing cause be removed, these disturbed conditions re-combine in the molecule, its weakened chemical coherence is restored, and no change results. If, on the contrary, electric energy be produced, the disturbed conditions re-combine outwardly, the polar elements of each two adjacent molecules combining, with a neutralisation of their opposite electricities. In this case, then, the flow of the electric current is accompanied by a chemical disintegration and reintegration, which extends in lines from the point of chemical action to the conducting poles. No energy actually passes. The energy emitted by the chemical action is employed in neutralising the opposite electricity of the

adjacent molecule of the electrolyte. A like neutralisation proceeds throughout the electrolyte. The pole of the last molecule in contact with the solid conductor yields its free energy to this conductor, and that element of the molecule which constitutes this pole is set free. Thus at the poles of the electrolyte the chemical disintegration becomes effective. In this process the passage of energy is but from molecule to molecule. The energy emitted at the battery plate is only a counterpart of that yielded to the conducting wire. The electric influence has made its way across the electrolyte without any passage of a distinct volume of energy through the liquid.

In the passage of electric energy through a dielectric there is reason to conclude that a like decomposition occurs, though it is not succeeded by a recomposition in the above sense. For the appearance of ozone, when this dielectric is the atmosphere, indicates a separation of the oxygen molecule into its constituent atoms, and a subsequent combination of these atoms with other oxygen molecules. Perhaps the resistance to chemical disintegration and direct reintegration may be an essential cause of the resistance to electric conduction. A similar action is indicated by the supposed production of nitric acid in the air through the agency of the lightning-flash.

If, then, in all cases in which we have an opportunity to trace the mode of electric conduction, it presents this character, we certainly have great reason to conclude that this is its essential mode, and that the passage of electricity through a solid conductor is performed in the same manner. It is certainly highly improbable that electricity has two distinct and widely different modes of movement, and far more probable that it is conducted in the same manner where we cannot, as where we can, trace its movement.

It may be, then, that in all cases the electric conduction of energy proceeds as follows:—An inductive disturbance of molecular motion precedes the current. The molecules become positively electrified at one pole, and negatively at the other. The influence which produces this polarisation acts to prevent a re-combination of the molecular energies inwardly, and tends to produce such a re-combination outwardly. The adjacent poles of every two contiguous molecules being respectively positive and negative, the constituents of the molecules separate, and the opposite poles of each two adjacent molecules combine, their diverse motions also combining into normal heat-vibration. In nonconductors this disintegration is vigorously resisted, and

there may be no immediate integration. In imperfect conductors, as in the electrolytic liquids, it is less vigorously resisted, and immediate production of new molecules occurs. In good conductors, as in the metals, resistance is greatly reduced, and a chemical change, like that in electrolytes, may take place with great readiness. And it is not improbable that the matter which passes from pole to pole may be set free as a final resultant of this process of chemical change. It is, however, not impossible that in these good conductors the neutralisation of the disturbed force may take place by a vibratory swing of molecule to molecule, each yielding energy to neutralise the disturbed condition of the next, without any necessary disintegration.

The essential point, however, is that there is no actual passage of energy throughout the circuit at the speed of the electric current. The real transfer of energy is comparatively slow, if it exists at all, and the energy which flows into one end of the circuit is simply balanced by an equal volume of energy which is set free by the molecules at the other end of the circuit, or at intermediate points in the circuit where the local transfer is resisted. There is, in this method of transfer of energy, a close analogy to the action of a row of elastic balls, of which, when the first is struck, the last starts into motion without any visible disturbance of the intermediate ones. The motion here is transferred from ball to ball by a series of elastic repulsions, and the motion displayed by the last comes from that immediately adjoining it, and in no exact sense from the first.

The above hypothesis indicates a close relation between chemical change and electric action. Chemical change takes place between heterogeneous molecules, which, at every approach, produce this inductive disturbance in each other. Such a disturbance weakens the cohesion of the constituents of the molecules. As the molecules approach each other the electric polarisation increases, and cohesion decreases. When very close the cohesion of the elements of the molecules may give way, and new molecules form in consequence, with the production of a new chemical compound. But in every such case there must be an electric current, through the best available conductor, this being ordinarily the material immediately surrounding the combining elements; and there must be a production of heat at some point in or throughout this circuit, in exact accordance with the energy set free in the chemical action.

The process of electric conduction here indicated finds significant analogies in certain phenomena of the current.

In a galvanic battery, for instance, the current produced is only that of the terminal cells of the battery. The internal cells add nothing to the volume of the current. Each of these, in fact, sends positive energies in one direction to meet the negative sent in the opposite direction by the next cell. Neutralisation, therefore, takes place between every two cells, and only the energy of the terminal cells flows over the wire. Thus each two cells act in the same manner as each two molecules in the above hypothesis, and the energy produced by the chemical action in each two becomes heat in the intermediate conductor. The only advantage of a many-celled battery is that each assists in the polarising action, so that the polarisation of the intermedium becomes great, and resistance to electric transfer correspondingly decreased. A like condition exists in the thermo-electric circuit. The current is only that of the terminal pairs, each intermediate pair acting the part of two intermediate molecules in a circuit. But increase in the number of pairs adds to the polarisation of the molecules of the circuit, and therefore to the electromotive force.

We have, thus, the following significant indications of the real process of electric conduction. In the case of static electric charge there appears to be molecular neutralisation of the electric disturbance internally, so that only the surface charge persists. In the galvanic current that portion which passes through compound liquids does so without any definite transfer of energy, but by a series of decompositions and recompositions, there being thus an internal neutralisation of the electric disturbance, the motive energy which appears at one end of the circuit not being that which entered at the other end. In the passage of the current through the atmosphere we have significant indications that the process is the same as the above, in the production of ozone as a resultant of chemical change. Other indications which point to the same conclusion we have just seen to exist in the action of the galvanic battery and of the thermo-circuit. There is no complete electric circuit through the battery. Neutralisation of the electric disturbance takes place between each pair of cells, while final neutralisation of the electric disturbance caused by the terminal cells takes place through the conducting wires. The same rule holds in the thermo-battery. Thus, instead of there being any complete electric circuit, there is a series of successive neutralisations of the opposite electric energies between every pair of active nodes in the circuit. In the case of the atmospheric and the electrolytic

portions of the circuit we perceive that this process of neutralisation takes place between every two adjacent molecules, the positive and negative polar energies of each being neutralised by a process of reintegration, and only the energy of the terminal poles of the molecular circuit being yielded to the solid conductor. Are we not, then, justified in concluding that the current passes through the solid conductor in the same method that successive molecular neutralisation takes place with possible reintegration, and that the energy which appears is the energy set free by the poles of the terminal molecules? This is certainly far more probable than that there are two distinct and unrelated methods of electric conduction.

The next point of importance in this connection is the production of heat in the circuit. This heat is precisely equal to that which would have been set free at the point of chemical action had there been no electric circuit. The energy yielded by the chemical action is simply transferred by the electric movement, to appear as heat throughout the circuit. And the quantity of heat which appears at every point in the circuit is in exact accordance with the resistance to polarisation at that point. If the total resistance of the circuit exceeds the total polarising energy no current can pass; but the instant the polarisation exceeds the resistance the current passes, and the heat produced at every point is in accordance with the resistance at that point. Thus the sum of heat yielded is in exact proportion to the sum of resistances, and these, in their turn, to the sum of polarising force, or of energy yielded by the chemical action. This energy, therefore, produces the same heating effect whether set free in the cell or in the circuit. And necessarily the greatest production of heat is at the point of greatest resistance to polarisation, this being found, when the poles are not in contact, in the dielectric medium separating them.

(To be continued.)

IV. SHAM EMPLOYERS.

By J. Hepburn Davidson.

"A goodly apple rotten at the heart ;
O ! what a goodly outside falsehood hath !"
Merchant of Venice.

MANY employers are misjudged ; many wronged by the vituperative tongue of their *employés*, and often condemned by the too open ear of the outside world ; but there is still a heavy percentage of employers in general who richly deserve censure, and amongst those who do so no one is more prominent than our every-day business companion, the *Sham Employer.* Let us watch some luminary of the commercial world in his office. The bland courtesy which he displays to outsiders is exchanged for grim sternness. He tyrannises over his clerks, and especially bullies the one who receives the lowest pay. This unfortunate being, often subject—in accordance to agreement—to dismissal at a moment's notice "for gross misbehaviour," must beware even of a sorrowful look, which his lordship, the "Sham," might construe as a frown of disrespect. With managers or especial assistants, who have often a superior knowledge of the business, and by whose well-worked brains he earns his wealth (though he has not the grace to own it), the "Sham" plays a different game. He entices or forces some subordinate to play the spy upon their doings and sayings, in the hope of discovering some error, oversight, or transgression : for, strange to say, some employers do not like a servant against whom no charge can be brought.

Many employers are spoilt by lending a too credulous ear to the false tales of inferior servants, thereby losing the services of one who thoroughly knows his duty. A case happened in Scotland which is worthy of notice :—A certain gentleman advertised for a chemist and manager able to erect plant, &c., which was duly replied to by a friend. He entered upon his duties, and had erected nearly three-fourths of his plant, manufacturing at the same time with the first portion of the structure a sufficient quantity of goods to cover expenses. Suddenly an aspect of dissatisfaction came over his employer, and at the same time he noticed in his foreman an equivalent rise of confidence amounting to impertinence. This foreman was engaged not that he knew

his work, but for his "general good character and veracity." It is a general custom of some Sham Employers to give good credentials to nuisances that they wish to rid themselves of. At last the crisis came, through the utter defiance of his workman to obey him in regulating a furnace heat, who, after a little parley in words, put on his coat and walked out of the place, after throwing a threatening look behind, as much as to say "I'll do for you." Next morning the foreman in question quietly donned his best suit of clothes, and proceeded to meet his master at the railway station. Having met him, and having got over his employer's astonishment at seeing him off duty (as that species of men generally impress upon their masters the notion that their services are indispensable), he explained the reason of his absence in the most exaggerated terms, at the same time making personal allusions as to my friend's character, which was blameless. Our poor credulous Sham hired a cab, and at the same time lowered his dignity by driving a Judas with him to the Works. On arriving he at once charged against my friend the allegations that his subordinate had loaded him with, and would not even listen to the manager's denial of the charges, but in a patronising air told him to behave better in future, and ordered the foreman to take his place as usual, thus reinstating scandal and hypocrisy, and countermanding his manager's wishes. What man of education, and especially one who knew his profession thoroughly, and who was lining his employer's pockets with money, could bear this? You may act the philosopher to a certain extent, but at the moment injured innocence is predominant in man's feelings. The result was that our over-credulous and biassed employer lost a valuable help. He also lost heavily, as few were qualified to finish the plant or work it from where it was left, and those few would not engage with him, as they were established elsewhere and the positions they held were good. Other managers were tried, but the specialities to be manufactured were a puzzle to them, and he had to give up the idea of that manufacture and pursue a less lucrative branch, much to his own chagrin and to the amusement of others. I decidedly call this type of employer "Sham," from his over-credulous ear to an under workman, ignoring his manager's word, and listening to the preliminary scandal and stories of the workman, whilst at the same time acting with a fair hypocritical demeanour to his manager till the final crisis came.

Another one of the type is the "Sham" who would force untrue results from his servant, and if not complied with

instant dismissal is the result. In this case the incident happened in a large manure works employing a staff of three chemists. The head of the laboratory was a conscientious, scrupulous, and accomplished chemist, a neat manipulator who very seldom erred in his results. A sample of coprolites was sent up to the laboratory for analysis, with orders for his immediate attendance in his employer's room. The employer, in the course of general business conversation, actually wished his principal chemist—offering him a bribe—to report the phosphate of lime contained in the sample 3 per cent lower (phosphates were then at a high price per unit): naturally his *employé* was staggered, and, loving his professional repute and integrity better than his situation, took the wise course, and left. He threatened to expose his "Sham" master, but the other only laughed and remarked the utter absence of witnesses, and also threatened in return to raise an action for defamation of character. Another feat of the same gentleman was to order a mixed manure of a certain strength from his foreman (this foreman had been several years in his employ, and had the confidence of all around him), and afterwards to bribe workmen overnight to mix the heap with gypsum and sand, so as to depreciate the value. After the manure went through the process of chemical analysis, it was found wanting, and the consequence was the poor foreman had to leave with no recommendation for another situation. It turned out afterwards that a workman and he had words, the "Sham" having wished him to do some dishonest trick which his servant would not accede to, and his removal was effected by foul means, as described above.

All the above statements are well authenticated, and many readers will be horrified at the amount of subtle hypocrisy and craft exercised by dishonest employers. Better serve a stern, tyrannical, honest master, who exacts duty to the utmost, rather than a sneaking and scheming employer whose selfishness has deprived him of all moral feeling.

Some districts have more refined masters than others, and it is often found, though peculiarly inconsistent, that an uneducated master, rough and ready, is the most straightforward and honest. It may be that his very ignorance keeps down that refined diplomatic cunning which helps a man, dishonestly inclined, to injure another, and yet hold up his head in society.

In large chemical works, where the laboratory should be well stocked with apparatus and reagents of the highest attainable purity, so that the chemist may have a fair chance

to bring out good results, these are often refused by the tyrannical "Sham," who with an unblushing face in the commercial world boasts of the purity of his manufactures, and praises his chemist for the great ingenuity and skill he has displayed in the erection of most impossible plant; at the same time the poor chemist is plodding away with his make-shift apparatus, and struggling hard with his impure reagents to get his results correct, as his percentage is generally high above the mark. Let us take a glimpse at his laboratory:—On first entrance the place appears to be a ricketty hovel of a few panels nailed together. Along these panels a few shelves are set, and placed on these shelves we see a series of straggling bottles, of divers sizes, containing the reagents already mentioned, which, when pure, are the analyst's principal weapon. Near, a little dirty window, which it is impossible to see through; but if it were possible the look-out would not charm your fancy, as a series of not over-firm pillars sustaining the vitriol chambers meet the view, and it is not at all pleasant to reflect that through the penuriousness of an employer a few score tons of vitriol and lead may at any time pay respects to your cranium, when the only solace awarded would be a word of posthumous pity from the local press. The balance before us when new might have weighed the tenth of a grain, but now in its old age persistently refuses to turn clearly with one grain. Our harassed chemist is sitting, trying to make a quick and *accurate* weighing of a soda-ash, the results of which must be forwarded to head-quarters in ten minutes, and must exactly agree with the report of another independent analyst whose laboratory contains every modern appliance, whose balance will turn to a nicety with the five-hundredth part of a grain, and whose standard solutions are made up with the purest acids, while our hard-working technical chemist is begrudged his pure reagents when they have to be bought, and his standard acid must be made up of the crude pyrites-product manufactured in the Works, and contaminated with iron and arsenic. His weighing is scarcely effected when a Mercury from the office enters, and states that the "Guv'nor 's in a fearful fury, and says that he 's taking all day about that analysis." Our analyst was perspiring before, but now his nervous excitement predominates, as he knows what his master is. He now proceeds to titrate, and, having finished doing so, takes his reading and calculates, and finds to his horror that he is 2 per cent too low. What is to be done? There is no time for repetition. During his dilemma his employer enters, and uses language which dare not be

described, at the same time acquainting him with the fact that if the report was not forwarded by fifteen minutes, and that to coincide with the other analyst, he would be subject to dismissal as incompetent. I may scarcely add that the poor trodden-down chemist was dismissed for the tyranny of an ignorant rule-of-thumb alkali manufacturer, who would not scruple to violate the day on which we all of us should rest, by working him as hard as on any week-day. Many a scientific man is rendered careless in his professional habits in the laboratory by such employers. He gets into a slip-shod habit of performing his analysis, and learns the dishonest method of making up his results, commonly called "cooking" by the profession. A systematic "cooker" is generally well versed in the average percentage of the various samples he gets, and makes up his book accordingly, so that it can bear inspection by one of his profession, leaving alone a rule-of-thumb master who duly appreciates his smartness in executing his analyses.

There are other very high class "Sham Employers" commonly met with in the first laboratories. The principals of these abodes of learning are outwardly perfection, but inwardly "a goodly apple rotten at the core."

Sham Employers are so plentiful that it is dangerous to engage in a situation. The only apparent remedy is for the *employé* to make arrangements that references are mutually interchanged, but the danger even then is that one "Sham" will refer to another, and his servants are dumb. Strict enquiry through other firms of high standing may throw a ray of light; but the best advice is to try the place, do your duty, and care for no man.

The Institute of Chemistry was to have abolished the evils above mentioned. Has it even taken a step in that direction?

V. SANITARY REFORM AND ITS VAGARIES: THE SANITARY INSTITUTE OF GREAT BRITAIN.

IT being, apparently, an established fact that these islands are sadly under-peopled,—that we have food without eaters, work without workers, and space without occupants,—we are as a nation greatly exercised on the question of diminishing the death-rate. We have accordingly a movement among us known as "Sanitary Reform"—a movement boasting its statesmen ranging in type from the Conservative enunciator of "*Sanitas sanitatum et omnia sanitas*" to the Whig *doctrinaire;* its *savans* and—let it be whispered in confidence—its charlatans also. The latter are chiefly to be congratulated. Science is to them not "the high, the heavenly goddess," but the sturdy mule on which they ride to fame and fortune.

Leaving these worthies for a time, let us ask what our speeches and our lectures at the Sanitary Institute, our Commissions, and our letters to the "Times" have really brought about? We know little more concerning either the treatment or the prevention of cholera than when it first invaded us. Medical authorities of repute are beginning to doubt whether the immunity from Oriental plague which we have enjoyed for the last two centuries is due to our own skill and wisdom or to circumstances equally beyond our knowledge and our control. The very disease which we boasted of having overcome has recruited its strength, and returns upon us every few years in epidemic proportions, revealing the following curious case;—an evil increasing *pari passu*—if not faster—with its remedy. The mountains have certainly not brought forth a Megatherium.

But there is in Sanitary Reform and its upholders a certain degree of inconsistency, often overlooked. War is waged against "zymotic disease" only. Fevers, cholera, small-pox, diphtheria, and their allies are to be rooted out by any and every means. But does any Sanitary Reformer ever class among preventible diseases that long train of neuroses—affections of the nervous system—which culminate in madness, paralysis, apoplexy? Does any Institute ask earnestly whether it be true that such ailments are increasing

rapidly among us, what can be the cause of such an increase, and if nothing can be done to stay the growing evil? We do not in the least seek to under-rate the importance of the latest phase of Sanitary Reform, the agitation for a smokeless and fog-free atmosphere in our cities. But for one person killed outright, or enfeebled by a foggy atmosphere, we believe that many are cut off or debilitated by nervous disease, the offspring of worry and anxiety. It seems to us almost farcical to see persons connected with the system of competitive examination—and therefore promoters of worry—anxious about such a minor evil as a stove which does not consume its own smoke. The victims of fog are to a great extent elderly persons, whose part in the world is already played. Those who fall a sacrifice to examinationism—and they include a serious proportion of the successful as well as of the unsuccessful candidates—are young men who, had their strength not been exhausted by hurried work under the pressure of anxiety, might have done a good life-work, and become the fathers of vigorous descendants. By the wonderful scheme that we have devised they are reduced to shadows; "mox daturi progeniem deteriorem."

But even within the limited sphere of action which official sanitary reform has chalked out for itself,—to wit, the purification of the soil and the waters from animal, and especially human, excreta,—there is a want of broad views, of candour, of a disposition to recognise and to acknowledge the truth. All differences of climate, soil, situation, &c., notwithstanding, the work must be done in one way only—irrigation. Our true *doctrinaire* sanitary reformer seems to wear a kind of mental spectacles which enable him to ignore or to misconstrue facts in the most singular manner. Some years ago an expert, of irrigationist proclivities, came over to England from abroad, and inspected the principal systems of dealing with sewage. At the Knostrop Works, Leeds, looking through the spectacles aforesaid, he saw "six iron tanks." Men not provided with such optical instruments can see merely *twelve tanks of masonry*, and none of iron! That the writer's report on less palpable matters was not unimpeachable may well be taken for granted.

Again, we find it asserted, by men who ought to know better, that though earthy and metallic salts may precipitate the *suspended* impurities in water, they have no action upon the *dissolved* impurities. This statement has been made, among others, by a gentleman—neither physician, chemist, nor engineer—who had been "cramming" in order to read

a paper before a body which by its rules allows no man to bring before it matter not (in part, at least) the fruits of his own personal experience. This statement having been repeated in a morning paper, a chemist and physicist, of world-wide celebrity, wrote to ask upon what evidence so extraordinary a dictum was based? *His letter was refused insertion.*

As to the truth or falsehood of the assertion, let us remember that a very great part of the arts of dyeing and colour-making depends on the property of precipitating dissolved—not suspended—organic matter, possessed by metallic salts. Or, turning to a direct experiment, we would recommend all whom it may concern to take a sample of ordinary town-sewage, and filter it through a double-fold of the finest Swedish paper, so as to remove all suspended matter. If the bright, clear liquid which runs through is then mixed with a neutral solution of a salt, say of aluminium, it speedily becomes cloudy, and deposits a greyish precipitate. This deposit, if examined, is found to consist of nitrogenous organic matter along with a basic salt of aluminium. Comparative analyses of the water, before and after precipitation, corroborate the result, showing that the proportion of organic nitrogen is seriously lessened by the treatment with, *e.g.*, aluminium chloride. We wish that the zealots of irrigationism would condescend to perform this simple experiment, and lay to heart its lessons.

We turn to the late Royal Commission on the Pollution of Rivers, which lies sadly open to the charge of having merely sought for evidence in support of a foregone conclusion, carefully declining to see any facts of different tendency. It might be pointed out as very strange that this Commission should have consisted of one chemist, two engineers, and not a single physician. We should have formed it of two physicians and one chemist. But, passing over this peculiarity of constitution, let us ask what has become of the *last* report issued by the *first* Commission, of which Mr. Way was a member? It is known to have been drawn up, at least as a rough draft, but it has never been issued to the public, nor has its non-appearance ever been accounted for. Such an occurrence conveys to our mind a very unpleasant impression.

Among the strange, or rather the inexplicable, assertions made by the second Rivers' Pollution Commission is the statement that a certain precipitation process could not be worked without causing a nuisance in the neighbourhood. It is no exaggeration to say that it would be easy to find a

thousand utterly disinterested witnesses—medical men, chemists, engineers, municipal authorities, &c.—who have visited and carefully inspected places where the process in question was being worked, and would declare the above charge utterly unfounded. It has, indeed, been formally denied in the official report drawn up by Mr. Keats, chemist to the Metropolitan Board of Works, by the Sewage Committee of the Leeds Corporation, &c.; yet the slander—we can use no milder term—is still circulated as an argument against *every* chemical method of treating sewage, and its authors have never had the honesty to come and examine whether an observation, *perhaps* made under some peculiarly unfavourable circumstances, in the very infancy of sewage precipitation, holds good at the present day. Again, it was said that the effluent after treatment contained more ammoniacal salts than the original sewage. This was at the time perfectly true, and the Commissioners well knew wherefore,—that is, because ammonia alum was injudiciously used as a precipitating agent. Mentioning the fact they ought, in common candour, to have mentioned the cause, and to have admitted that such cause has been removed, and that the charge falls to the ground. So far from this, a former *attaché* to the Commission has repeated the statement within the last few years, though if at all acquainted with the history of the sewage-question he must know that in the process in question ammonia alum has long ago been laid aside in favour of cake alum (aluminium trisulphate).

Turning to another quarter: a precipitating process was worked experimentally in 1872, under close inspection. The chemical report as to the purification of the water and the freedom from nuisance was most favourable. The expense of working the process was made out to be ruinously heavy; but by what means? Coal was in the year 1872 at a fancy price, and the process was debited not with the ordinary cost of fuel, but with this special figure. Sulphate of alumina commanded then double its present price. More than that, in their anxiety to make the cost of the operations appear prohibitive, the authorities in charge insisted on debiting the process with the salary of a chemist who went down daily during the three months' trial to draw a check-sample of effluent water on behalf of the patentees! Yet in spite of the introduction of these and other palpably anomalous items, the document in question is still paraded by irrigationists as a proof of the prohibitive cost of chemical methods of sewage-purification.

But we must approach our more immediate question.

Before us lies a paper bearing the heading "Proceedings of the Sanitary Institute of Great Britain, June 21, 1881. Abstract—The Present State of the Sewage Question. By Prof. W. H. Corfield, M.A., M.D." In this document we find the words—"The *various chemical processes* for the treatment of sewage were *passed in review*, and *all* shown to be *quite* inadequate to cope with the difficulty." Now we have the authority of gentlemen present for declaring that *not even an attempt* was made to pass the chemical processes in review and to show their inadequacy. The subject was discreetly avoided. How, then, must the unqualified statement just quoted be characterised?

Prof. Corfield did indeed mention as untrustworthy—we believe a stronger term was used—the analysis of an effluent water obtained by a chemical process. Whence the effluent in question had been obtained, or by what process produced, the lecturer did not think it necessary to mention, but the figures quoted were identical with those obtained by Prof. J. A. Wanklyn on analysing a sample of effluent produced at Aylesbury by the process of the Native Guano Company, April 26th, 1880. The numbers were—Grains of chlorine per gallon, 3·2; free ammonia, per million, 0·05 part; albumenoid ammonia, 0·30, or only one-tenth part the proportions considered as admissible by the Rivers' Pollution Commissioners in their celebrated "Recommendations."

We learn, and we understand it could be judicially proved if necessary, that the samples operated upon by Prof. Wanklyn were taken by a Buckinghamshire sanitary inspector, without any warning given to the Native Guano Company or their officials. It seems to us that an attempt to discredit the work of a chemist of Prof. Wanklyn's known eminence, on mere conjecture, is, to say the least, highly indiscreet.

We must also remind Prof. Corfield that Prof. Wanklyn's analysis, whilst totally uncontradicted, is substantially confirmed by those of independent authorities. Dr. R. Angus Smith, in an official report, gives the Aylesbury effluent water a very high character. Surely, therefore, it may be contended that the lecturer's zeal had outrun his discretion. Judicious chemists are in the present day very cautious as to pronouncing on "chemical impossibilities."

Just as the defects of sewage precipitation were magnified, so those of irrigation were overlooked or understated. No one can deny that the effects of irrigation are to reduce the temperature of the soil, and thereby, in our climate, to retard the crops. This result is complained of at the

boasted sewage-farm of Gennevilliers, near Paris. Here there are produced great store of vegetables, strawberries, &c., but they come in late, when such articles have become a drug in the market. "Crops of all kinds had been grown by means of it (sewage irrigation)." Yet the committee appointed by the Local Government Board in 1876 are very far from recommending it for "crops of all kinds." For white crops it must be applied with great caution, even in the driest weather. Potatoes are not benefitted by it; with turnips the results are doubtful. The success has been greatest with rye-grass and mangolds. But it is very questionable whether rye-grass would be profitably saleable if produced on the large scale. As to mangolds we would suggest the following test:—Take a ton of mangolds grown by ordinary methods of cultivation, and another ton produced by sewage irrigation. Store them up separately in pits side by side, and examine after a few weeks which lot is the sounder. From cases which have come to our knowledge we will venture to say that the sewage-grown roots will be found largely rotten.

Here we are brought to the experiments of Dr. Smee, jun., which have never been refuted, and which *doctrinaire* sanitarians meet with the "conspiracy of silence." It was found that the juice of sewage-grass was chemically different from the juice of normal grass, and entered more rapidly into decomposition. It was observed that the milk of cows fed on sewage grass putrefied earlier and became much more offensive than the milk of cows fed on animal grass. Irrigationists dare not repeat these experiments and wish them to be forgotten.

We fully concede that in climates where a dry season occurs, or where rainfall is small,—either absolutely or in proportion to evaporation,—irrigation may be, and often is, the one thing needful to convert a desert into a garden. In Britain, where injury from drought is rare, and where our crops suffer almost yearly from an excess of moisture, the case is very different.

At one time it was contended that manures in general might be advantageously applied to the land dissolved, or at least suspended, in water. Experience did not confirm the expectations held out, and this method of manuring land has fallen into disuse. Is not this a case in point?

As regards the results put forward by the Sewage Committee of the British Association, to which Prof. Corfield refers, we have not forgotten that the independent members of that Committee found themselves compelled to resign,

and that the report ultimately adopted was a mere one-sided affair. The said Committee is declared to have "shown"— a favourite word in the "abstract" before us—that "as great a percentage of the manurial constituents of fœcal matters had been utilised as was on an average utilised of the best commercial manure." Yet, unless our memory greatly deceives us, it has been admitted by Prof. Frankland that from one-half to two-thirds of the nitrogen present in sewage may pass away from an irrigation field in the effluent water! This is very poor utilisation.

The dangers from the proximity of sewage farms are by no means purely imaginary. Even in India, where lands are irrigated with plain river-water, and only when the state of the weather renders such irrigation needful, it has been found necessary to prevent irrigation from being carried on within a certain distance of villages and to interpose a screen of trees. Is it conceivable that irrigation as conducted in England, with sewage applied at all times instead of clear water, used only when needed, will be the safer? If the proximity of a polluted stream is dangerous, is the danger lessened by spreading out the polluted waters over a larger area? Sewage-fungus is by no means unknown in the water-courses issuing from irrigation farms. That disease-germs are not necessarily arrested or destroyed by passing water through a vast mass of earth is shown by the celebrated Swiss case described by Prof. Frankland, where a stream which soaked through a mountain conveyed disease from one valley to the next.

As regards the economy of irrigation it has not been found upon the whole very satisfactory. Blackburn, Tunbridge Wells, and other places have found a sewage-farm a somewhat costly luxury. The report issued by the Committee of the Local Government Board tells us duly, indeed, under each town, that the capital sunk in buying and laying out a sewage-farm will be paid off in so-and-so many years, and the rates will then be reduced by a certain figure in the pound. But this comforting assurance is built upon the somewhat doubtful assumption that a given number of cubic feet of soil can go on for ever disinfecting putrescent animal matter. It is highly probable that further outlay will be required for extensions.

We fail to see, judging from the "abstract," that Prof. Corfield has advanced anything which has not been asserted and re-asserted many times during the last ten years. He brings forward no new arguments against "precipitation," he overlooks the improvements which have been made in its

practical working, and which enable it to produce results very different from anything ever realised, *e.g.*, at Leamington. Nor is he apparently able to point out any advances in irrigation, or to show the way of avoiding its besetting difficulties.

To prevent all misunderstanding it may be well to state that the present writer, though he has had thirteen years' experience in different processes of sewage-treatment, has no interest in the success of any scheme, either as a shareholder, patentee, or official, and judges from the point of view of an independent outsider.

VI. ON THE PROBABLE EXTENSION OF SOLAR PHYSICS TO MATTERS AFFECTING THE AGRICULTURIST, MERCHANT, AND MAN OF SCIENCE.

By A. H. Swinton.

THE scientific mind has of late years been gradually awakened to the important fact that a certain class of natural phenomena, on which mankind are greatly dependent for the future development of their resources, are immediately controlled by, and in direct subjection to, the central luminary of our system. Terrestrial magnetism, electrical activity, periodical variations in temperature, periodicity of wind disturbance, and annual rainfall have especially occupied attention in this respect; and their various phases following the vacillation of the spots on the sun's photosphere have been observed, recorded, and finally drawn up in tables and diagrams. From these indices we may now glean that as the sun's atmosphere of light, every eleven years or so, wanes and again replenishes itself, so will cold and warm seasons, cyclones and rainfall, disturbances along the electric wire, oscillations of the compass, and other symptoms in our sky and soil that receive the solar rays, follow each other in due sequence. Medical science, too, has not been oblivious to these periods of solar energy and

weakness, and not a few attempts have been made to correlate them with seasons of famine, plague, cholera, and other epidemic visitations. But with all this scope of inquiry indicated or grappled with, many other phenomena which the record of the past would lead us to associate with certain meteorological conditions, and therefore with solar physics, remain for the most part the subject of vague conjecture and inane speculation. Chief among these come, perhaps, seismic phenomena, including earthquakes, volcanic emanations, and hot springs; and entomological phenomena, such as insect multiplication and migration. As regards the first class of disaster—despite a prevailing astronomical bias to the theory propounded by M. Cordier, of a subterranean tidal disturbance governed by the moon, which yet remains a question—much that is palpable can be adduced in favour of the influence of the sun, more especially perhaps in the frequent arrival of these manifestations simultaneously about the equinoxes, and their recurrence in periods more or less marked. As regards the second class of subordinate phenomena more can be affirmed, and taking the insect plagues best known in the commercial world—such as locusts, corn weevils, and wheat flies—it may be fairly stated that their periods of increase and diminution show fair promise of exact co-ordination with the solar registers.

If we take, for instance, the rocky mountain locust (*Caloptenus spretus*), the scourge of the Western States of America, we shall find that its permanent region and native breeding-ground lies within the northern temperate zone, between 37° and 53° N. lat. Its migrations have been, on the whole, in a southerly direction east and west of this region; and from an analysis of the table given in the "Annual Report of the United States Entomological Commission for the year 1877" (p. 113) it is distinctly evident that the periods of migration and increase of this species coincide with the sun-spot minima, while its years of decrease as closely harmonise with the maxima, in neither case there existing the difference of a year. We also know as regards the multiplication and migration of various locusts in the cereal districts on the borders of Europe and Asia, from long tradition as from recent more exact evidence, that droughts coming about the minimum period of the sun-spot cycles are their time of increase. The evidence, however, is here of a more general description, and not so precise as in the case of Prof. Riley's elaborate reports, it being well known that "locust" in itself is a very wide and indefinite word to an entomologist. However accepted as a term of common

parlance denoting an insect of the Orthopterous class, it will be found that various records of locust increase, about the year 1810, along a line extending from Egypt to India, are extant: 1823 was a year when they commenced their depredations in the Crimea; in 1833 they were destructive about Marseilles; 1845 and 1866 mark ever memorable years of havoc in Algeria; all and each of these epochs indicating, as will be seen by reference to Wolf's tables, the minimum period of sun-spots as now more or less established.

But it must not therefore be assumed that all destructive insects have the same period of multiplication; for while the corn weevils of our granaries, or certainly the more destructive sort which is imported from the marts of the South, have shown a tendency to increase about the minimum of spots, it has likewise in measure been ascertained that the wheat flies (*Diploxis*), of which there are said to be two varieties, affect in Germany a decennial period recurring towards the maximum years. This phenomenon, I think, is in some cases doubtless attributable to the circumstance of the greater uniformity in the solar action within the zone of the tropics, and in others to the circumstance that insects are variously adapted to conditions of climate.

If, however, species thus show a tendency to increase at different periods, and there be recurring times when certain families and certain individuals find themselves in the most congenial of circumstances for multiplication, there yet remain fixed epochs when a general move is witnessed in the mass of the insect fauna. These, north of about 45° N. lat., alternate rather than agree with the extremes of solar energy, so that the great European migrations, as obtained by tabulation of pamphlet notices, may be stated to have recurred regularly every eleven years since 1846, or at times when the sun-spot average has been 48·6 according to Mr. Norman Lockyer's method. The set of these migrations has been north and west, and in this direction rare butterflies, sphinx moths, and locusts, whose home has been traced to southern Asia and northern Africa, travel periodically; the inauguration of the occurrence being made known by their vanguard, so to speak, sweeping over the eastern shore of our island. That this track is not voluntary or chosen by instinct, as some have supposed, but due rather to a prevailing south-easterly direction of the wind, is a matter that now-a-days rests on a great amount of experience and observation.

It is likewise of interest to note, in connection with these flights, that although they traverse Europe between the

extremes of solar power, they often originate, and in cases can be traced to, a multiplication of species that has transpired during the minimum period. Especially is this probable with regard to the locust inroads which, pushing northwards, have found their chroniclers since the Christian era, and which, from unknown climatic or agrarian reasons, appear formerly to have been more formidable or more dreaded by an ignorant population. Another minor migration of European insects, much less marked, occurs in the same direction as the greater flights between the maxima and minima sun-spots, or when the index points at 38·5; I am, however, unable at the present moment to affirm whether this faunistic displacement should be attributed to the greater or less period of solar force.

I think I have here adduced sufficient to show the importance of solar physics, and to indicate their probable line of extension to a common ground where the man of merchandise may meet with his scientific brother, and learn the reason of his triumphs and losses, which, by being recorded, may eventually be remedied. But not alone the merchant; the astronomer likewise has somewhat to learn of the entomological record, for he will here find ready data which when elaborated will allow him to extend his solar cycles back into the Dark Ages which preceded Schwabe and Galileo, and in this wise:—Since on tabulation it will be seen, even at first sight, that ancient locust invasions in Europe have taken place at intervals that homogenise with those following modern migrations; and since the latter intervals come on at the maximum of spots, when the insects regularly disappear and the ravage ceases; few will doubt but what in collating the evidence of the havoc we are virtually pointing the sun-spot maxima. So from what has been before adduced the minimum periods may be similarly approximated and fixed, by correlation of the records of locust multiplication in localities situated on the edge of the northern tropic, as, for example, the districts of southern Europe and northern Africa, Persia, or China.

ANALYSES OF BOOKS.

The Cat. An Introduction to the Study of Back-boned Animals, especially Mammals. By St. George Mivart, Ph.D., F.R.S. London: John Murray. 1881.

A large handsome volume entitled "The Cat" will probably cause some little surprise to the ordinary reader as to what can be found to fill it. An animal which is as much an object of aversion to some as it is a pet and a friend to others would hardly be deemed worthy of being honoured with so splendid a monograph.

A careful inspection of the book itself will not only show how much valuable and interesting matter has been collected by the author, but will even suggest the thought that the volume, large as it is, might have been considerably extended without exhausting the subject.

The cat is throughout the work treated as the type of the Vertebrates in general and of Mammals in particular. The reason why the cat is selected will best be explained in the author's own words in the Preface :—" It might perhaps be expected that Man himself would be chosen as the type. But a fresh description of human anatomy is not required, and would be comparatively useless to those for whom this work is especially intended. For a satisfactory study of animals (or of plants) can only be carried on by their direct examination, the knowledge obtained from reading being supplemented by dissection. This, however, as regards man, can only be practised in medical schools. Moreover the human body is so large that its dissection is very laborious, and it is a task generally at first unpleasing to those who have no special reason for undertaking it. But this work is intended for persons who are interested in zoology, and especially in the zoology of beasts, birds, reptiles, and fishes, and not merely for those concerned in studies proper to the medical profession. The problem has been to select as a type for examination and comparison an animal easily obtained, and of convenient size; one belonging to man's class, and one not so different from him in structure but that comparison between it and him (as to limbs and other larger portions of its frame) may readily suggest themselves to the student. Such an animal is the common cat. In it we have a convenient and readily accessible object for reference, while the advantages which would result from the selection of Man as a type will almost all be obtained without the disadvantages of that selection."

The introductory chapter is one that will be read with equal interest by student or general reader, and contains much to please and instruct.

The domestic cat is shown not to be the wild cat (*Felis catus*) tamed, but is supposed to be a descendant of the sacred cat of the Egyptians, possibly with an admixture of other blood, the parent of which was the *Felis maniculata*, a native of Northern Africa. The domestic cat was a rare and valuable creature in England during the Middle Ages, while the wild cat was extremely common. So great a value was set upon the animal towards the end of the sixth century that the laws of Wales, Switzerland, Saxony, and other European countries, imposed a heavy fine on cat-killers.

"The domestic cat is an animal so common and familiar that its utility is sometimes apt to be lost sight of. To realise its usefulness we must imagine ourselves in a land where no such animal is known, but where the annoying creatures upon which it preys shall have multiplied with the rapidity natural to them. The familiar tale of Whittington may serve to illustrate what would be the effect of its introduction into such a land. It has been calculated that a single cat may devour twenty mice in one day; but this of course is by no means the limit of its powers of destruction. Its effect in putting to flight the creature it pursues is again far in excess of its destructive energy. Were every cat in England simultaneously destroyed, the loss through the entailed increase of vermin would be enormous.

"But however much this animal may deserve our esteem, or win our admiration, by its shapely form and graceful movements, it certainly has very special claims on the attention of lovers of biological science. For in the first place its organisation, considered absolutely in itself, is one of singular perfection, and the adaptation of means to ends which it displays is truly admirable. If, however, we compare its organisation with that of other animals, we shall by so doing not only gain a better appreciation of its structural perfections, but also become acquainted with a variety of relations conveying useful lessons in anatomy, psychology, and zoology, and others referring to the past, the present, and even the future history of this planet."

So much for the author's own apology for his selection of the cat: the latter part of this very interesting chapter explains very fully the object and scope of the work.

The next eight chapters are devoted to an exhaustive account of the anatomy of the cat, occupying about one-half the volume: here we have evidence of the author's patient investigations, and his determination to aid to the utmost of his power those wishing to study the anatomy and histology of vertebrate animals. The writer has evidently seen and carefully examined everything that he describes, and this, undoubtedly the most valuable portion of the whole book, is unsparingly supplied with

all necessary illustrations, microscopical and anatomical. The tenth chapter is devoted to Embryology, and is quite as complete and exhaustive of the subject as the preceding treatise on Structure.

The Psychology of the Cat is treated of in a more extended sense than is usually applied to the term. In the author's words it denotes "the study of all the activities, both simultaneous and successive, which any living creature may exhibit," and does not merely signify mental states. With regard to the latter part of the subject, the "Cat-mind," a quotation will best explain the author's views :—

"We cannot of course, without becoming cats, perfectly understand the cat-mind. Yet common sense abundantly suffices to assure us that it really has certain affinities with our own. Indeed the cat seems to be a much more intelligent animal than is often supposed. That it has very distinct feelings of pleasure or pain, and keen special senses, will probably be disputed by no one. Its sense of touch is very delicate; its eyes are highly organised * and can serve it almost in the dark, and its hearing is extremely acute. It is also obvious that external and internal sensations, more or less similar to ours, by which we move instinctively from place to place, judge of distance and direction, and perceive resistance and pressure, must be possessed by the cat also. The ease and grace of motion in the cat, and its neat dexterity, are a common subject of praise." Much more in this chapter as to the high mental endowments of the cat, but, however interesting the subject, the temptation to quote further must be resisted : it is only to be regretted that additional information respecting cat-life has not appeared in an appendix.

Then follows a description of fifty species of living cats, and also a full account of fossil species, which appear to have been somewhat numerous. This chapter is liberally illustrated.

The chapter on the Cat's place in Nature, in which the author answers the question "What is a cat?" is a grand lesson in classification. After disposing, in a brief manner, of the differences between minerals and organised beings, the vegetable kingdom is separated from the animal. The lower animal king-

* Page 290, after describing the structure of the choroid and its lining with a layer of dark pigment cells, excepting at a part called the *tapetum*, "a roundish patch occupying most of the back of the inside of the choroid, and including within it the entrance of the optic nerve. It is this tapetum which gives the eyes of cats that luminous appearance in obscurity, by reflecting the light—a property which is supposed to assist their nocturnal vision."

"At my request Mr. Henry Power has been so kind as to examine the cat's eye with the ophthalmoscope, and says 'I owe you my thanks for directing my attention to one of the most beautiful things I have ever seen. Imagine a dense, yet luminous, velvetty blackness below, bounded by a nearly horizontal line, just above which is a pearly spot—the entrance of the optic nerve. This presents the usual vessels emerging from it. The disc is surrounded by a sapphire-blue zone of intense brilliancy, passing into metallic-green; and beyond this the tapetum shines out with glorious colours of pink and gold, with a shimmer of blue and green. It is really lovely.'"

doms are then dealt with, and the type (the cat) compared with each, and the agreements and differences carefully noted. No one could read carefully this earlier portion of the chapter without learning much concerning the whole of the Invertebrata. Fishes, Batrachia, reptiles, and birds are then compared with the cat: the same plan is still adhered to, but as the structure of the types described becomes more complex, so greater extension of the comparisons is more and more fully worked out; after each the matter is summed up in a useful tabular form; at last the Carnivora are reached, and here the differences are still more minutely defined. The verdict as to the cat's place in the animal kingdom can only be given in the author's own words:—

"The cats are then Carnivora *par excellence*, and they carry out the type of their order to its higest known and most perfectly harmonious expression. Spontaneous activity and sensitiveness are the special characteristics of animal life, and with both these powers cats are largely endowed. It may be objected, however, that the activities and sense perceptions of certain other beasts are, in their own various ways, as highly developed as are those of the *Felidæ*. It is certainly very true that it is only through the possession of perfectly-formed bones and muscles, of a delicate sense of hearing, or of far-reaching vision, that antelopes, hares, and such creatures, escape their carnivorous pursuers. But then they use their organisation only for *escape*. The organisation of the cat tribe may then be deemed superior, because it is not only excelled in itself, but because it is fitted to dominate the excellences of other beasts. Thus considered, the Carnivora would rank first amongst mammals, and the cats would rank first amongst the Carnivora. Man, however, is a mammal, and therefore to affirm this would be to affirm the inferiority of our own species. But man's superiority is mental; it resides in his intellect, not in his peculiarly formed great toe, hand, pelvis, or other corporeal peculiarity. Man is to be regarded in two lights—as a truly intellectual being, and as an animal with a certain organisation. Viewed in the first mode he stands quite apart from and outside the whole visible creation, and has simply no place whatever in any scheme of biological classification. Considered merely in his capacity as an animal, he has a very definite place in such a scheme, but it is by no means certain that his place is at the summit. Our powers of locomotion and sense perception are quite inferior to those of very many beasts; and though our brain is large, both absolutely and relatively, yet such are the variations in this respect, presented by animals of different groups, and by different animals of the same group, that the naturalist would be a bold one who should venture to affirm that a brain-classification of vertebrate animals—to say nothing of Invertebrata—would be a satisfactory one. The close bodily resemblance of the apes to man gives them no just claim to a rank above that of the Carnivora, since such

a claim only reposes on their bodily resemblance to ourselves. As to their intelligence, no evidence seems to be forthcoming that it is superior to that of the dog or the elephant, though their close likeness to ourselves gives to their tricks a deceptive appearance of rationality which we must always be careful adequately to discount if we would correctly estimate their real worth. It is therefore true that 'something may be said in favour of cats being the highest of mammals,' if man be considered merely in his animal capacity,—in which alone he can be brought into comparison with other organisms. But whether or not this eminence be allowed to the cat, there can be no question but that it is the most highly-developed type of carnivorous mammalian life—the most perfect embodiment of a 'beast of prey.' Such, then, is *certainly* the 'CAT'S PLACE IN NATURE.'"

The chapter on the Cat's "Hexicology" treats on the cat's relations to its surroundings, including physical conditions, geographical distribution, palæontology, and its relations to other living beings. Among cats' enemies the most troublesome are internal and external parasites: of these a goodly list are given. From their habit of feeding upon small animals, cats—as the owners of these pets well know—are particularly subject to the attacks of various Entozoa, and the ravages of these worms are common to the whole family.

The work concludes with a chapter on "The Pedigree and Origin of the Cat." An abstract of this important part of the book would be impossible, from the necessarily complex argument involved, and quotations here and there would do no justice to the author; let it suffice to say that the chapter is the finest in a splendid book. The writer's aim is to teach the truth, and not to support a view.

The book will take its place as one of the most valuable monographs yet produced.

Education, Scientific and Technical; or, How the Inductive Sciences are Taught, and How they Ought to be Taught. By ROBERT GALLOWAY, M.R.I.A., F.C.S. London: Trübner and Co.

FOREIGNERS often wonder by whom the examinational system of education rampant in England and in China is really defended. Our scientific discoverers—we need only mention the names of Huxley, Crookes, and Lankester—reject it with contempt; our most learned medical authorities denounce it as ruinous to the mental constitution not merely of the present, but of future generations, and pronounce the work of the Civil Service

Commissioners individually and racially destructive.* Actual experience—the hard logic of facts—shows how inferior we are in the quantity of first-rate intellectual work produced to the nation which discards emulation from its system of education, and which is in consequence of its thoroughness leaving us more and more behind, not merely in scientific research, but in the industrial arts. Who, then, are the infatuated individuals who still hug this delusion, compelling our schools and colleges, often against the better judgment of their principals, to proscribe all original thought? The answer is not far to seek. The mischief is due to politicians ever ready to sacrifice such a trifling matter as the intellectual life of the nation to the exigencies of party. To those who see a little farther and more clearly than a certain peer who recently defended competitive examination in public, the intellectual and physical degradation of a great part of our most promising young men seems far too heavy a price to pay for the suppression of "influence." To call examination a test of merit is ridiculous indeed, if we call to mind the cases placed on record within the last few years, of two men taking high honours respectively in chemistry and biology, though the chemist had never cleaned out a test-tube, and the biologist never looked through a microscope or determined a vegetable or animal species! But as this evil system is defended by men who, for our sins, are invested with power and influence, the work of Prof. Galloway is most opportune.

The author's object is, as he admits, not perfectly explained by the title which he has given his book. He begins with the fact, now generally admitted, that in higher education—whether of an abstract or of an industrial character—we are inferior to certain of our neighbours, especially Germany. It is not generally known in this country that for annual fees of about £15 a young man can obtain—*e.g.*, at the Polytechnic School of Aix-la-Chapelle—a technical training quite as good as that given in the Royal School of Mines, and more varied in its nature, according as the student seeks to qualify himself for the duties of a technological chemist, a mining, civil, or mechanical engineer, &c. It cannot fail to be known to all that Germans are continually flocking over to this country, and, in virtue of their superior education, supplanting the natives in almost every sphere where technical skill is required. Prof. Galloway asks, What is the reason for this inferiority? He shows that the defect does not lie, as is often said, in the mere want of funds. At the same time it may, perhaps, be thought that some of the money now expended in forcing elementary education upon those who do not want it might have been better applied in supplying higher education to those who are craving for it.

Neither are our shortcomings due, as the author shows on good

* *See* Journal of Science, 1881, p. 440.

evidence, to any inherent defects in the British and Irish mind. The causes, which are very complex, include the want of unity of design in our national institutions. We set two or three distinct bodies to do work which should be committed to one alone. He quotes from Dr. Weise the very just remark that with us "public instruction in general does not show a progress towards objects clearly recognised and defined. An extraordinary amount of power, time, and money is still wasted, from a want of plan and unity."

Another evil lies in our defective patent law, which renders it almost impossible for a poor man to secure a right of property in his ideas. We venture to say that the patent laws of the United States are in themselves a most powerful agency for the technical education of the American people.

Another cause of our deficiencies lies in our excessive attachment to literature as compared with physical science. We love words and dreams rather than things. We honour the orator, the novelist, the historian, the lawyer, the popular preacher, and the political agitator, far more than the inventor or the discoverer. And as men, of whatever mental calibre, cannot dispense with food, shelter, and clothing, it follows that a majority of our best minds gravitate towards the pursuits which are most honoured and best remunerated. Even in the present day, when efforts are being made to supply better facilities for scientific culture, the friends of literature, not yet satisfied with the lion's share of time, funds, and honours which they already possess, cry out for more. It seems that a college which shall confine itself to Science must not exist in England.

But if Prof. Galloway somewhat overlooks the exclusively literary tendencies of the average Englishman, he is the more explicit and satisfactory on the defects of our method of teaching. Our cardinal sin is the almost exclusive cultivation of verbal memory. This, again, is a necessary result of the system of prizes, certificates, and of competitive examination in all its phases. The teacher is, directly or indirectly, paid by "results." The more of his pupils "pass" such and such an examination the more will his reputation and his emoluments rise. Hence this "passing" becomes a primary object. As our author puts it, he selects those of his pupils who have a good verbal memory, joined, we may add, with glibness of speech and a considerable share of assurance, and to these he pays his almost exclusive attention. These select few he trains up not in a thorough knowledge of the subject, but in the art of answering questions upon it. What those questions are likely to be he ascertains approximately by collating the examination papers of former years, and by carefully studying the whims and the predilections of the examiner. He knows what theories the latter believes in, and whose text-books he prefers.

It is plain that by this process a kind of unnatural selection is

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effected, most unfavourable to merit. For what class of pupils are best calculated to shine under this system? Let us take two lads, A and B. A has an inquisitive, thoughtful, suggestive mind. If a fact is laid before him he begins to ponder on its possible bearings. If a theory is brought forward he instinctively asks for its evidence. Meantime B, blessed with a retentive memory and a rapid power of reproduction, gobbles up all that is thrown before him, and is able to bring it forward again, wrapped in a torrent of verbiage, at a moment's notice. B passes, in virtue of his very shallowness and emptiness; A fails, in virtue of the very fertility of his mind and his inclination to follow out every idea to its consequences. Yet this is Earl Kimberley's "merit!"

Students are examined, not *e.g.* in chemistry, but in what Prof. Frankland or some other reputed authority has written upon chemistry. We hear, therefore, of men "reading" for a degree, not "working" for it. The difference is heaven-wide. Hence, as the author quotes from Dr. Playfair, we have "faithful disciples rather than independent thinkers. The diversity of teaching in different universities tends to mitigate this evil, but the uniformity of *a common system of examination vastly augments it.* When Government takes graduation in hand, and stamps our intellects, as it does its sovereigns, with one uniform die, the power at its disposal will be immense; but, as in France, the intellects will in time be crushed under the stroke, and then will not be worth the coining."

It might have been expected that Englishmen, once proud of their mental independence and individualism, would have resisted such a system to the death. But alas! we look on in apathy whilst a *parvenu* bureaucracy casts the intellects of our youth into one and the same mould, and positively restrains our teachers from throwing into their work individuality and intelligence.

If we look to the German universities we find, on the contrary, diversity. Each of the great laboratories presided over by Bunsen, Hofmann, Kolbe, Fresenius, &c., has its distinguishing features. In other sciences it is precisely the same. A student will, therefore, after passing a couple of terms at one university, proceed to another, where he may have the opportunity of working under Prof. X or Y, and of studying his science from a different point of view. "Here in England teachers can display no such independence of thought; they have to walk themselves and make their pupils walk in the paths of science the examiners walk in, although they may not approve of it."

In Germany emulation and competition are not made the pillars of education. The Director of the Barmen Technical School declared that "the principle of competition was almost entirely excluded from their system, as tending to foster a servile view of education, and to lead to spasmodic and exhausting efforts and feverish excitement, rather than to the healthy and harmonious development of the mental powers."

Prof. Galloway, in our opinion, rightly contends that prizes and medals ought to be abolished, and that the teacher should not be paid by "results" in the cant sense of the term,—that is, by the number of his pupils who "pass" some particular "standard." In one sense—though in a very different one—German professors are paid by results. The "results" are the number and the magnitude of the discoveries and investigations emanating from their laboratories, whether physical, chemical, or biological. In proportion as such discoveries rise in importance students flock to the university, and honours and emoluments fall to the lot of the professor.

We regret that we must here, from want of space, break off our examination of Prof. Galloway's ideas, the more as we have not yet touched upon one important phase of the subject—his method of teaching the physical sciences. To this question we hope to return at no distant opportunity. Meantime we can do no other than pronounce the work before us an able, a wise, a timely, and a patriotic production—in short, a book after our own heart.

The Occult World. By A. P. SINNETT. London: Trübner and Co.

HERE is a book which will be in most quarters received with contemptuous incredulity, and flung aside after being made the subject of a few jokes. Such has not been our feeling. We are too bitterly conscious of the imperfect and fragmentary character of human knowledge,—too deeply convinced how frail are the foundations of many of our fashionable creeds,—to reject light coming from what quarter soever. We therefore opened this book in the hope of finding something definite and tangible. Our curiosity was raised by such passages as the following:—"Modern physical science has been groping for centuries blindly after knowledge which occult philosophy has enjoyed in full measure all the while." "Achievements far more admirable than any yet standing to the credit of modern science." "Secluded Orientals may understand more about electricity than Faraday, more about physics than Tyndall." "During a career which has carried occultism in the domain of physical science far beyond the point we have reached, physical science has merely been an object of secondary importance," &c. Physical science being for us an object of primary importance,—in fact, *the* object,—our interest and curiosity were most strongly excited, and we sought eagerly for some proposition, whether the statement of a fact or of a law of Nature, which should be capable of verification. Can no crumb be vouchsafed us of this alleged knowledge so far beyond our own?

There is, we are told, a force in Nature known in Sanscrit writings as *akaz*, said to be "as much more potent, subtle, and extraordinary an agent than electricity, as electricity is superior in subtlety and variegated efficiency to steam." But about the attributes and the laws of this force, and the manner in which it may be observed, we are told nothing! We find complaints of "the intricate suspicions with which the European observer approaches the consideration of the marvellous in its simplest forms. But, setting aside the idea of the "marvellous" as scarcely scientific, how can we, without the sceptical, critical spirit, separate truth from delusion? The man of science, if he finds in the quiet of his own laboratory, and without the presence of any other person, indications of a new element or of a new force, multiplies tests, and checks, lest he should unwittingly deceive himself, and the more widely the novelty stands apart from what has been previously known the more rigid is the scrutiny. Hence the treatment which the advocates of occult science receive, and which seems to them "tiresome and stupid," has in it nothing exceptional. But, indeed, judging from a letter of an adept, occult science is not something which can be superadded to our open modern science as a continuation or an improvement. We read—"You do not seem to realise the tremendous difficulties in the way of imparting even the rudiments of *our* science to those who have been trained in the familiar methods of yours. The more you have of the one the less capable you are of comprehending the other." Again, "Exact experimental science has nothing to do with morality, virtue, philanthropy, and therefore can make no claim upon our help until it blends itself with metaphysics." Hence to us men of the laboratory, the observatory, the zoological station, or the museum, this occult science has nothing to offer!

A number of occurrences are described in proof of the mighty, and to us unaccountable, powers possessed by the adepts. We do not presume to deny that these are records of actual facts; but we must be permitted to say that evidence very far more convincing, and incapable of imitation by jugglery, might easily have been produced. If such men as Koot Hoomi Lal Singh were to announce some fact not at present known, such as the existence of an undiscovered planet, the presence of an as yet unrecognised element in some particular geological formation, &c., the verification of such predictions would silence all gainsayers.

It is here stated:—"The philosophical and transcendental notion of the mediæval theosophists that the final progress of human labour, aided by the incessant discoveries of man, must one day culminate in a process which shall result in the evolution of nutritious food out of inorganic matter, is unthinkable for men of science." Strange assertion! The synthesis of sugar, starch, fats, albumen, is not merely thinkable, but is being eagerly sought for.

We close this book not without regret. We are, we trust, open to any new truth. But unless the disciples of occultism can speak more intelligibly they had surely better keep silence altogether, and not raise expectations which they have always such a wealth of good reasons for not gratifying. But how profound soever may be the Science of the Oriental adepts, what would be the use of their communicating it to Englishmen? We should simply incorporate it in our different grades of cramming, and examine unfortunate young men in it. So long as we put our knowledge to this use it may fairly be contended that the less we have the better.

Songs and Sonnets of Spring-time. By CONSTANCE C. W. NADEN. London: C. Kegan Paul and Co.

HERE surely is a twofold marvel—that a poet should care for notice in our highly prosaic pages, and that the subject-matter of some at least of the poems in question is such that we may examine them without inconsistency on our own part. It must not by any means be supposed that all men of science regard poetry as "mere sensuous caterwawling." The thoughtful ethnologist sees in it an index of national life: where it ceases to appear, or, if appearing, to be appreciated,—as in modern England, or in Greece of the post-Periclean epoch, or in Rome after the days of the twelve Cæsars,—such national life is fading. Where it never has appeared the nation, as a whole, has not yet begun to live, in the higher sense of the word, and perhaps never may do.

The "Songs and Sonnets" before us have an especial interest as dealing, to no small extent, with certain scientific and philosophic subjects. Let us not be mistaken: we have here no elementary treatise or handbook done into verse. Miss Naden pictures the man of science clinging with devotion to his chosen pursuits, and yet ever and anon regretting to what an extent his researches cut him off from the sympathy of his kind. Thus, in "The Astronomer," she writes:—

"Bright hieroglyphs I read in Heaven's book;
  But oft, with eyes too dim for these,
In half-regretful ignorance I look
  On common fields and trees.

Scant fare for wife and child the fisher gains
  From yon broad belt of lucent grey;
Rude peasants till those green and golden plains;
  Am I more wise than they?

Oh, far less glad! And yet could I descend
  And breathe the lowland air again,
How should I find a brother and a friend
  'Mid earth-contented men?"

What man, devoted to scientific research, does not find such thoughts passing at times through his mind? But yet, with the authoress, he can truly say,—

> "Now has the breath of God my being thrilled,
> Within, around, His word I hear;
> For all the universe my heart is filled
> With love that casts out fear.
>
> My sight, love-strengthened, Time and Space controls;
> No more are Force and Will at strife;
> Beyond the scene I pass; around me rolls
> Infinite circled life."

Somewhat similar, but less calmly hopeful, are the meditations of the "Alchemist"—thoughts such as may have occurred to a Paracelsus, or a Raymond Lully in the evening of his days:—

> "In lonely toil my manhood has been spent,
> Spurning all ties of home, all joyance free;
> And now my heart is sick, my frame is bent,
> And I would sleep, but rest is not for me.
>
> I conquer still, though strength may not be mine
> To drink the cup my dying hand prepares;
> My life, but not my triumph, I resign,
> For all mankind shall be my deathless heirs.
>
> I care not who the victor's crown may wear,
> I care not though my bones neglected lie;
> This is my latest, this my only prayer—
> Come life, come death, let not my wisdom die."

Surely these words are not unworthy of the grand old sages who first smoothed the roads along which we are travelling!

From "Light at Eventide" we quote the reflection:—

> "Evil has brought good, but good in turn
> Brings evil forth, and painfully we learn
> The rich resulting harmony of life."

Throughout these poems we find, indeed, full evidence that the writer is familiar with the highest conceptions of modern philosophy. She embodies its doubts, its struggles, its aspirations,—beautiful indeed, but with that autumnal, or sunset-like, kind of loveliness which pervades all modern English poetry.

We are particularly struck with a short piece, "Das Ideal," written in German, which would not have disgraced Heinrich Heine, and from which we quote the following lines admirably embodying the longings of the thinker:—

> "Zerreissen will ich die geträumten Schleier
> Des Stoffs, des Raums, der Zeit,
> Und mich ergiessen, frei und immer freier
> In die Unendlichkeit."

"The Lady Doctor" is a comical portrait of one of the characteristic phenomena of the present day. "Love *versus* Learning" embodies the meditations of a maiden who had planned "to be a philosopher's bride," and with that view had become engaged to an Oxford examinee, and discovers his shallowness.

> "He's mastered the usual knowledge,
> And says it's a terrible bore;
> He formed his opinions at college,
> Then why should he think any more."

Our readers, if inclined to blame us for noticing this little collection of poems, are recommended to read it for themselves, when they will doubless give us a full pardon.

Australian Aborigines. The Languages and Customs of several Tribes of Aborigines in the Western District of Victoria, Australia. By JAMES DAWSON. Melbourne, Sydney, and Australia: George Robertson.

CONSIDERABLE attention is now being paid in all parts of Australia to ethnological research, under the impression that if the opportunity is not at once taken the gradual decline of the native tribes will soon make the undertaking impossible. Even now it is difficult to sift the original ideas and beliefs of the "black-fellows" from such as have been acquired from the settlers. The author forms a very favourable opinion of the natives in many respects. He praises, *e.g.*, their sanitary observances. They invariably bury all excrement in the earth at some distance from their dwellings, though their reason for this wise practice is based on superstition. It is a curious fact that a black louse which formerly infested the natives has disappeared, and the white louse of Europe has taken its place. The common flea was also not indigenous,—a fact to be weighed by those who maintain that such vermin have some important function to fulfil.

The cleanliness of the natives must be taken in a relative sense, if we remember that they coat their bodies with a paste made of grease and red clay. As far as the tribes in question are concerned, we learn that "the figures of human beings, animals, and things now drawn by the natives, and represented as original in works on the aborigines of Victoria, were unknown to the tribes treated of, and are considered by them as of recent introduction by Europeans."

Concerning food they have a mixture of notions, some sensible and others exceedingly foolish. They are said "never to touch

putrid flesh, except that of the whale," and yet a few lines lower down we read "they have no objection to eat tainted flesh or fish: if it is too far gone it is roasted, to expel the unpleasant flavour." It seems to us hard to draw a definite line between what is putrid and what is tainted. Fish that have been exposed to the rays of the moon are rejected as poisonous. A similar notion prevails in many other parts of the world, and it is maintained that such fish or other animal matter is particularly liable to putrefaction.

The explanation has been suggested that dew is deposited most abundantly in moonlight nights when radiation from the earth's surface is unchecked. Now if dew consists of moisture condensed in the lower regions of the atmosphere, it may not improbably be fraught with the spores and germs of microbia, including some capable of bringing on malignant fermentations. The prohibition of certain classes of food to persons of one sex, or at some particular time of life, does not seem capable of a rational explanation.

Their exceedingly complicated marriage laws are said to have been devised to prevent the intermarriage of blood relations. Any physical advantage hence derived is probably more than counterbalanced by the polygamy permitted to the chiefs, who, though mostly old men, are permitted to monopolise the finest young women.

A kind of python, about 10 feet in length, is met with in Victoria, and sometimes attack human beings. They are much dreaded by the natives. The carpet- or tiger-snake is also said, contrary to the general law laid bown by Waterton, to attack men without provocation.

Mention is made here of the "bunyip," a nondescript animal inhabiting water-holes, concerning which the natives relate sensational stories. It is said to carry off a man in its mouth. Making all proper deduction for exaggerations, it is possible that the "bunyip" may be some Saurian which has not fallen into the hands of any naturalist. The descriptions given do not, however, suit any kind of crocodile, as this animal is said to have a long neck and to have the power of erecting its head.

Native tradition speaks of a huge bird, probably the moa of New Zealand.

A species of eagle, not named, occasionally attacks young children, and is much dreaded by the natives.

Traditions of earthquakes, and even of volcanic action, still survive.

The bulk of the work before us is devoted to the languages of the West Victorian tribes, and contains extensive vocabularies arranged in parallel columns.

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

AËRIAL NAVIGATION.

To the Editor of the Journal of Science.

Sir,—As the writer of the greater part of the article on "Aërial Navigation" in "Progress of Science" for May, I trust you will pardon my referring to the criticism thereon in the July number of "Journal of Science."

The objection therein made to such "an enterprise" is "that it will give a fearful advantage to aggressive war."

Believing as I do that the ultimate result of aërial navigation will be to practically abolish war, which I cordially detest as being inimical to progress, I regret that the mass of arguments for or against any views on the subject must be merely speculative so long as the chief problems of aëronautics are publicly unsolved. I can therefore only tender opinions in place of arguments.

The first I quote are those of an eloquent writer in "Scribner's Monthly":—

". . . The great peoples of Christendom soon will arrive at a common understanding; the Congress of Nations no longer will be an ideal scheme, but a necessity, maintaining order among its constituents, and exercising supervision over the ruder, less civilised portions of the globe. . . . *War between enlightened nations soon will be unknown.* Men will see 'the heavens fill with commerce,' but after a few destructive experiments there will rain no—

'ghastly dew
From the nations' airy navies grappling in the central blue.

Troops, aërial squadrons, death-dealing armaments will be maintained only for police surveillance over barbarous races, and for instantly enforcing the judicial decrees of the world's International Court of Appeal. . . . Material progress determines the intellectual and spiritual progress of the human race. Its

true perfection must follow this ultimate conquest of Nature, and can be reached in no other way. . . . "

An "editorial" in the "Scientific American" embodied an opinion that the inventor of a reliable aërial machine would deserve to rank as one of the greatest benefactors of the human race, because, as aqueous torpedoes have almost abolished naval warfare, aërial torpedoes must lead to the abolition of war of every kind.

The third opinion I refer to is that of the Poet-laureate, in "Locksley Hall."

It seems to me that, as aërial navigation will "practically obliterate boundaries," there will be no frontiers ("scientific" or otherwise) to fight about; whilst ethnic, religious, and political jealousies must gradually disappear, "when races and languages shall be mingled as never before."

Therefore the chief causes of "aggressive war" will be annihilated by this "art of the near future."

AËRONON.

[We note the expression "ultimate results." These may perhaps be all the writer pictures. But what about the *immediate* results? We fear they would be horrors such as the world has not yet witnessed.—ED. J. S.]

NOTES.

THE occurrence of diatoms in the London Clay has been confirmed by Mr. W. H. Shrubsole, F.G.S. They were first noticed during the sinking of a well at Sheerness in 1877-8, and described in the "Proceedings of the Geologists' Association" (vol. v., p. 355); but, as the appearance of diatoms were not at that time familiar to the author, they were described as minute unknown fossils; their appearance was that of metallic specks, or, under a slight magnifying power, minute disks of iron pyrites, having a boss in the centre and the edge slightly turned up all round. In 1877 Mr. Shrubsole had an opportunity of examining a slide of *Aulacodiscus Oreganus*, and was struck with its resemblance to the unknown minute fossils. The examination of specimens of clay was renewed, samples from wells at Sheerness—of dates 1781 and 1812—examined, and diatoms discovered, but only in a narrow well-defined zone at a certain level. Further observation has shown that they exist over a wide area, but still at the same level. Most of the diatoms are pyritic pseudomorphs, but a few are obtainable which have not been completely mineralised, and will bear examination with high powers and transmitted light. The paper concludes with some observations by Mr. F. Kitton, Hon. F.R.M.S., and a list of species determined by Mr. Shrubsole, Mr. Kitton, Dr. Bossey, Dr. Stolterfoht, and Mr. G. D. Brown.

A Parliamentary Return shows the number of experiments performed on living animals during the year 1880 by medical men and others licensed under the Act. The experiments were in most cases performed at laboratories connected with the universities in England and Scotland, or at hospitals or veterinary institutions. The experiments numbered 311, of which only 114 can have been the cause of any pain, and of these all but 17 were of a kind involving no more pain than is experienced in ordinary vaccination. The painful part of the proceeding in the 17 cases involving pain was made under anæsthesia, and no appreciable suffering can be said to have been inflicted beyond confinement until the wounds healed or until the animals were killed. The most important results have been acquired in the elucidation of an obscure and fatal disease termed anthrax, which attacks sheep and cattle, and also persons engaged in wood sorting. Of this series of experiments 29 were undertaken at the instance of the Royal Agricultural Society, and 40 at that of the Medical Department of the Local Government Board.

Dr. G. W. Rachel ("Science," June 11) gives a very interesting paper on "Fossil Organisms in Meteorites." It is maintained that about fifty species of fossil Polypi, crinoids, sponges, and Algæ have been recognised in meteoric stones by Dr. Hahn, Dr. Weinland, and Prof. Karsten.

According to the "American Journal of Science" the speed of the Gulf-Stream, as it passes through the Bahama Channel, does not exceed 2½ miles per hour.

The applications of selenium to the photophone and to telephotography have been ably discussed by Mr. Shelford Bidwell in a lecture delivered before the Royal Institution. The author has explained the apparently capricious action of selenium by showing that there is a certain temperature at which it possesses a maximum resistance, diminishing rapidly as the temperature either rises or falls.

Dr. Arthur Schuster, in a lecture before the Royal Institution, has given an admirable summary of the teachings of modern spectroscopy.

The celebrated botanist and physiologist M. J. Schleiden died at Frankfort on June 22nd, in the 74th year of his age.

Prof. S. H. Scudder communicates to the "Geological Magazine" an interesting paper on two insect wings from the Dudley Coal field. To the one he gives the name of *Brodia priscotincta*, and to the other that of *Archæoptilus ingens*. The spread of wing of the latter insect must have been from 10 to 14 inches.

According to Dr. E. C. Hanson *Saccharomyces apiculatus* is an alcoholic ferment, feebler than *S. cerevisiæ*, producing bottom fermentation, but incapable of inverting cane-sugar or of throwing its solution into alcoholic fermentation. Its natural *habitat* and nutriment are gooseberries, cherries, plums, &c.

Mr. T. R. Dolan, F.R.C.S., describes in the "Medical Press and Circular" a case of hydrophobia, and remarks—"As one among many deaths that have occurred in Yorkshire during 1879, it convinces me that a more stringent Dog Act is required.

The Legislature of Massachusetts has passed an Act requiring railway *employés* to be examined for colour-blindness, and imposing a penalty of 100 dollars upon the company for each case of neglect.

We regret to announce the death of Prof. Rolleston, M.D., F.R.S., at the early age of fifty-two.

An insect plague—species not named—is said to be ravaging the agricultural districts of Lancashire.

M. E. Yung has reported to the Academy of Sciences on the influence of the nature of food upon the development of the

frog. He finds that tadpoles of one brood develope very differently, according to the nourishment which they receive. The articles used in the experiments favour the development of the tadpoles in the following order :—Beef, fish, coagulated white of hen's eggs, albumenoid matter of frogs' eggs, and Algæ. The two latter do not suffice for the transformation of the tadpole into a frog.

According to M. Jolyet the "*picote*" of pigeons is true variola.

The liquid ejected by the oak eggar (*Bombyx Quercus*), on emerging from the pupa, is opaque, of a yellowish buff colour, and has a well-marked acid reaction.

H. Horvath (" Physic. Med. Gesellsch. Würzburg ") concludes an experimental investigation on the hybernation of animals with the decision that " hybernation is not sleep, and has no connection with winter."

Prof. Seeley (" Geological Magazine ") criticises Prof. Carl Vogt's views on the *Archæopteryx*. He rejects the supposition that this species forms a marked intermediate type between birds and reptiles.

According to reports collected by Mr. Glashier, extending over thirty-two consecutive years, the proportion of dry warm seasons during the hay and corn harvest is about one in ten. This fact shows the importance, or rather the necessity, of the Gibbs hay and corn drying machine.

We are happy to learn that the Perthshire Natural-History Museum has become a reality. The institution is to be confined to the zoology, botany, and geology of Perthshire. We could wish that a similar museum for local Natural History could be founded in every county.

Prof. Semper has been examining the effect of differences in light upon young axolotls. In the dark they do not become white, but very dark; almost as dark in red light, rather paler in yellow light, and palest of all in full daylight.

The " Scottish Naturalist " for July contains the continuation of a most interesting biography of the meritorious Scottish botanist George Don.

The same journal gives a list of many plants, in the neighbourhood of Leith, which have either been killed or greatly damaged by the past severe winter.

Among the many and discordant voices now raised against Science must be counted that of Mr. Ruskin, who (" Fors Clavigera," Letter 53, pp. 138, 139) is guilty of this strange utterance :—" The instinct for the study of . . . the lower forms of

undeveloped creatures . . . is the precise counterpart of the forms of idolatry (expressed in the worship of unclean beasts) which were in great part the cause of final corruption in ancient mythology and morals."

We wish to call special attention to an Exhibition of appliances, fuels, &c., for the prevention of smoke in dwelling-houses and factories, to be opened on October 24th, under the presidency of H.R.H. Prince Leopold, Duke of Albany.

Mr. H. H. Howorth ("Geological Magazine") argues that the circumstances under which the remains of the mammoth are found in Siberia, prove that these animals must have been destroyed by a great, sudden, and permanent fall of temperature.

Prof. Hutchinson, in his Lectures on the "Laws of Inheritance in Relation to Disease," mentions the fact that colour-blindness is exceptionally common among Jews and Quakers.

The "Medical Press and Circular" justly remarks that "Of the rank and file of the æsthetic army, as of every hysterical school before, the majority are men of feeble intellectual development, and women of that ultra-sympathetic type which is one of the forms of disease most prone to excite pity and disgust in the mind of the physician."

Prevention of Forgery.—In our February issue we gave an account of the safety-paper devised by Mr. A. Nesbitt, F.C.S., to prevent fraudulent alterations in cheques. We now learn that another process for the same object has been brought forward by Dr. Dupré and M. Hehner, who appear to be chemists to the firm of Charles Skipper and East, cheque-printers. These gentlemen propose to print upon the cheque a mixture of zinc sulphide and lead carbonate; and they state that on treating the cheque with an acid or an alkali calculated to remove writing, double decomposition takes place, and the paper is darkened by the lead sulphide produced. This result undoubtedly happens with sulphuric acid at certain strengths. But if the *right* degree be hit, as we have seen it experimentally proved, lead *sulphate* is produced instead of *sulphide*, and the mixture and the paper to which it is applied remain white as before. Again, if alkaline solutions are used at random the mixture turns a brownish colour, and the attempt at fraud is betrayed. But if an alkaline solution is used of the proper strength, and containing a suitable proportion of sodium bicarbonate, the mixture of zinc sulphide and lead carbonate remains perfectly white, and the writing gradually disappears. Hence this invention would afford no protection against a clever forger, who would experiment till he had found the exact strength of the solutions to discharge the writing without blackening the paper.

NINETEENTH YEAR OF PUBLICATION.

THE

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AND ANNALS OF

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(MONTHLY, FORMERLY "THE QUARTERLY JOURNAL OF SCIENCE.")

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THE

JOURNAL OF SCIENCE.

SEPTEMBER, 1881.

I. THE CENTRE OF GRAVITY OF THE EARTH, AND ITS EFFECT ON ASTRONOMICAL OBSERVATIONS.

By Col. A. W. Drayson, R.A., F.R.A.S.

(Concluded from page 448.)

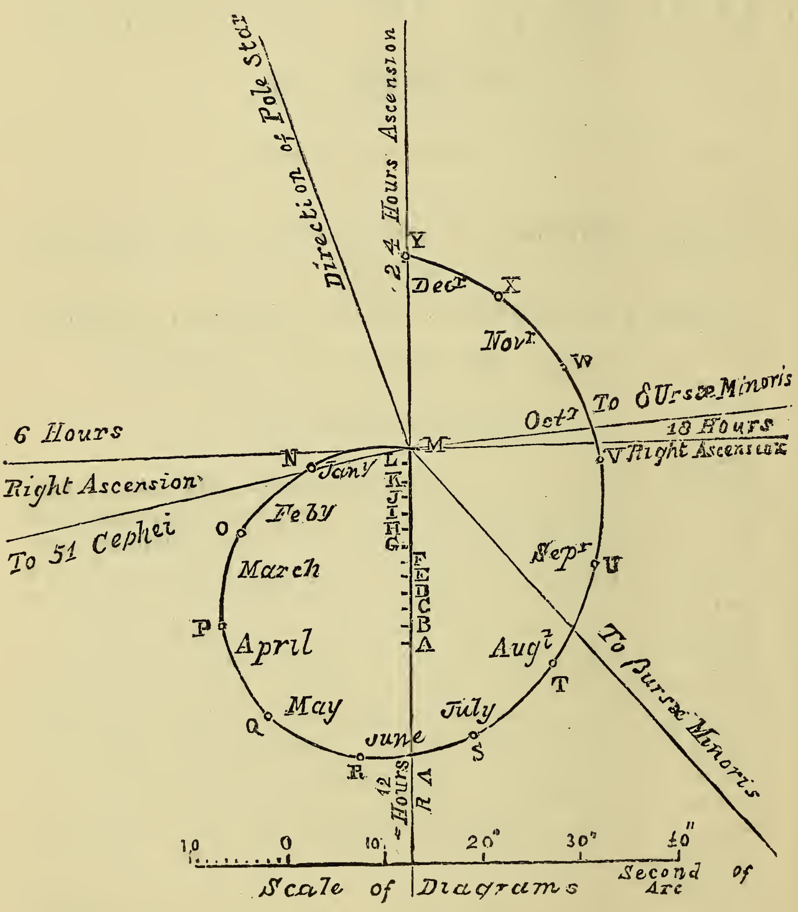
The Nautilus curve traced by each pole can be constructed from the data already known, viz., the North Pole changes its direction, due to the change in direction of the Earth's axis, about 20″·25 annually towards the first point of Aries. Whilst the North Pole is tracing this line, or arc, the zenith of the pole—found by a plumb-line directed to the centre of gravity of the Earth—will trace a circle round the movable pole; consequently, as the zenith of an observer at the pole is supposed to be the same point in the Heavens as that occupied by the pole, the appearance will be as though the pole itself actually traced the Nautilus curve, and the effects on stars declinations and right ascensions will be the same as though the poles traced this curve.

To construct the curve the following method should be adopted:—

Draw a line (A M, Diagram 3) of any convenient length, say 2 inches, and construct a scale of seconds of arc, so that A M on this scale is 20″·25 in length; the line A M represents the course of the North Pole towards the first point of Aries during any year. Divide the arc A M into twelve equal parts, to indicate the position of the North Pole on the 1st day of each month. Consequently A is the position of the North

Pole of the Heavens on January 1st, B its position on February 1st, C on March 1st, and so on. With a radius of 20″·7, a circle described round the movable points A, B, C, &c. will give the Nautilus curve, allowing $\frac{360°}{12}$ for the arc

DIAGRAM 3.



Apparent Curve traced by the Zenith of the North Pole annually, due to the position of the Centre of Gravity of the Earth.

for each month. Thus an arc of 30°, viz. N A M, will give M N, the course of the zenith at the North Pole during January.

With B as centre, and same radius, describe an arc of 30°, viz. N B O; N O will be the arc described by the zenith at the pole during February.

With C as centre, and same radius, describe an arc of 30°, viz. O C P; O P will be the apparent course of the zenith at the pole during March.

Proceed in the same manner, and the Nautilus curve is completed by the arc X Y, which is the arc described by the zenith at the pole during December.

The month indicated is written against each portion of the curve.

As the arc A M is towards 0 hours right ascension, 12 hours right ascension will be in the opposite direction, viz., in the direction M A; whilst 6 and 18 hours right ascension will be indicated by two lines drawn at right angles to A M and through M, 6 hours being on the left, 18 on the right. The scale at foot of diagram shows seconds of arc. The value of this curve can now be demonstrated, and its accuracy or inaccuracy tested by any reader acquainted with the mere elements of astronomy, for he will by aid of this curve be able to measure off the scale the actual changes in seconds in the declination of stars near the pole for each month in the year; also the changes in right ascension of all stars in the Northern Hemisphere. Any stars near the pole may have their direction plotted on the diagram, and their changes in right ascension and declination can be shown by this diagram.

Four stars near the North Pole will be selected, viz. the Pole Star, 51 Cephei (HEV), δ Ursæ Minoris, and β Ursæ Minoris, the direction of which stars is shown on the diagram; but it must be remembered that the distance of these stars from the pole is so great, when compared with the breadth of the curve shown on diagram, that the arcs from the pole to the star are *nearly* parallel to one another, no matter where the pole may be situated on this curve.

The effects on the polar distance of the Pole Star will first be examined, and the direction of this star is plotted on the diagram.

During the month of January the pole moves from M to N, or nearly at right angles to the arc joining the pole and the Pole Star. Consequently, on February 1st and January 1st, the polar distance of the Pole Star ought to be nearly the same. The observations of many years show that the polar distance of the Pole Star at these dates varies only 1-10th of a second. The curve, however, between M and N does bend slightly towards the Pole Star. So, if observation be correct,

the polar distance during the middle of January ought to be slightly less than on the 1st and 31st of January. Recorded observation gives 1″ for this decrease.

During February the pole moves from N to O, consequently obliquely away from the Pole Star. Draw a line from N away from the Pole Star, and from O draw a line at right angles to the line joining O and the Pole Star, and where this line intersects the line from N we obtain a point the distance of which from N will give the change in polar distance of the Pole Star during February. This measured distance is about 4″·3. Recorded observation gives 4″·3. During April the pole moves from P to Q; that is almost directly away from the Pole Star. Measure the arc P Q, and this arc by scale will give slightly more than 10″ as the amount by which the polar distance of the Pole Star increases during April. On referring to the "Nautical Almanac" it will be seen that between March 31st and April 30th the polar distance of the Pole Star increases 9″·1.

Following the curve we find that between R and S—that is, about the middle of June—the pole is moving at right angles to the arc then joining the pole and the Pole Star, at which date the pole cannot vary its distance from the Pole Star. On examining the "Nautical Almanac" (1880) it will be seen that on the 18th of June the pole does not vary its distance from the Pole Star. We may now test the amount of change in polar distance of the Pole Star between June 18th and the end of January, when a line from that part of the curve indicated by 18th June to the Pole Star cuts the arc N M near N. The length of this arc from scale gives 31″, which is the increase in polar distance of the Pole Star between January 29th and June 18th. Observation, as recorded in the "Nautical Almanac," gives 31″ for this change. As the curve traced by the pole moves round to S, T, U, &c., the pole decreases its distance from the Pole Star, and from V to W during October moves directly towards the Pole Star. The arc now traced each month is a longer arc than is the arc traced during the early months of the year. Consequently when we measure the arc V W from scale we find it slightly more than 11′, by which amount the polar distance of the Pole Star must decrease during October. The recorded observations in the "Nautical Almanac" give 11″·3 for the decrease during October.

We now refer to the monthly changes in right ascension as regards the Pole Star. When the pole is carried by the annual rotation from M to N the same effect on the right ascension is produced as though the star moved over a

similar arc in the opposite direction. Consequently during January the right ascension of the Pole Star will decrease rapidly. During the course of the pole from P to Q, during April, the right ascension will be *nearly* constant, and about April 1st—when a line from the star to the pole is tangential to the curve then traced by the pole—the right ascension at that date will not vary. Observation, as recorded in the "Nautical Almanac," agrees with minute accuracy with the above details.

Again, about June 18th the right ascension of the Pole Star will increase rapidly, whilst about the end of October —when the arc from the Pole Star to the pole is tangential to the curve—the right ascension will be again a constant. Observation proves this to be the case. The change in polar distance of the Pole Star between June and December can also be taken off scale, and the value found to correspond with observation.

We can now test the accuracy of this curve by another important star, viz., δ Ursæ Minoris. The direction of this star is also plotted on the diagram, its right ascension being about 18 h. 10 m. During January the pole moving from M to N moves directly away from δ Ursæ Minoris. Consequently the polar distance of this star will increase during January by the length of the arc M N: the length of this arc by scale taken off the diagram will be found about 9″·5, and the recorded increase in polar distance of this star—found after years of observation, and recorded in the "Nautical Almanac"—is 9″·2 for the month of January.

By examining the curve on diagram, the following questions can be answered:—

1. When will the polar distance of this star remain constant during a few days?—When the pole is near the point P, at which time the pole is tracing an arc at right angles to the arc then joining the pole and the star.
2. When will the polar distance of this star decrease most rapidly?—When the pole is moving from R to S; that is, during June, at which date the polar distance will decrease by the amount of the arc R S.

Examine the recorded observations in the "Nautical Almanac," and these two facts agree with the results of observation.

3. When will the polar distance of this star remain a constant during the latter portion of the year?—When the pole is at V on October 1st, at which date the pole is moving at right angles to the arc then joining the pole and the star.

4. What will be the greatest variation during the year between the polar distances of this star?—The greatest length of the arc, within the curve, of a line drawn parallel to the direction of the star: this arc it will be found is about 40″.

Again corresponding with recorded observations. The same test may be applied to the star 51 Cephei, or any other star near the pole, and the Nautilus curve will give the same exact results.

Consequently we have a curve which gives accurately by scale the changes which take place in the polar distance of any star near the North Pole during each month of the year. The same curve shows where the right ascension of *any* star in the Northern Hemisphere will change most during the year, and where it will be a constant. In all cases the right ascension of a star will be a constant when a line from the star to the curve is tangential to the curve, and the variation in the right ascension will be greatest when a line from the star to the curve cuts the curve at right angles.

The Nautilus curve which gives these exact results is the curve which would be traced at the pole by the zenith during a year, when observations were taken at the instants of time indicated by midnight at Greenwich, for each day of the year, and *due to no other cause than the fact that the centre of gravity of the Earth is not coincident with the Earth's centre.* This curve is at present unknown to astronomers or geometricians.

Having demonstrated the curve which applies to north stars, I next give the Nautilus curve for the South Pole. If the curve for the South Pole reveals equal accuracy, although a different curve, it seems difficult to find any more complete proof of the truth of the facts here advanced.

The Curve traced by the South Pole annually (Diagram 4).

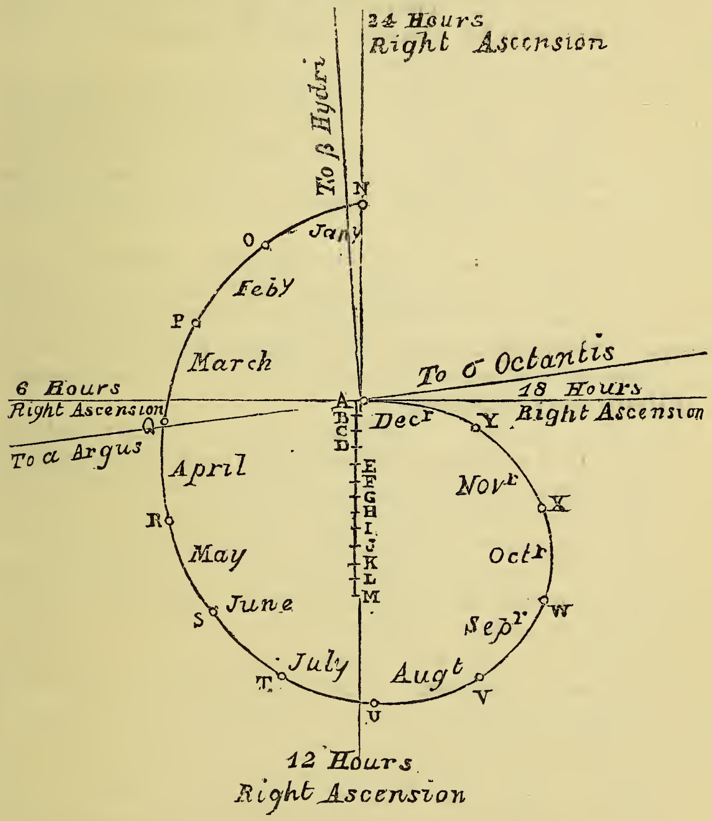
The annual rotation of the Earth causes the South Pole of the Heavens to trace a curve slightly different in form from that traced by the North Pole. The centre of the circle traced by the South Pole moves 20′·25 annually towards 12 hours right ascension, whereas the centre of the circle traced by the North Pole moves 20″·25 in the opposite direction,—that is, towards 24 hours right ascension.

The curve traced annually by the South Pole is constructed as follows:—

Draw the line A M 20″·25 in length; divide the line into 12 equal parts. This line represents the course towards

12 hours right ascension of the South Pole of annual rotation. The point A will be the position of this pole on January 1st; B its position on February 1st; and so on. If the annual rotation did not occur the pole N would, during the year, move down the arc N A. But the pole N rotates

DIAGRAM 4.



Apparent Curve traced by the Zenith of the South Pole annually, due to the position of the Centre of Gravity of the Earth.

round the moving centre, A, B, C, &c.; so that the pole N moves to O during January, to P during February, to Q during March, and so on, reaching the point near A on December 31st. The accuracy of this curve can now be tested by the aid of southern stars near the South Pole of the Heavens.

The first star we find in the "Nautical Almanac" having

south declination, and near the South Pole, is β Hydri, with a right ascension of about 19 m. = $4^\circ 45'$ in arc. The direction of this star is plotted on the diagram.

During January the South Pole, moving from N to O, increases its polar distance from β Hydri by the amount of the arc obtained by drawing from O a line at right angles to the line drawn from β Hydri through N, and measuring from N to the intersection. This arc by scale is slightly over 5″. Recorded observation gives 5″·2 for the increase in south polar distance during January.

When the pole is moving from Q to R, during April, it is moving directly away from β Hydri, and consequently increases its polar distance by the amount of the arc Q R. This arc measured off scale is about 11″. The recorded change in the "Nautical Almanac" for April is also about 11″.

When the pole is moving round that part of its arc between T and U, it is moving at right angles to the line joining the pole and β Hydri, at which date there will be no change in the polar distance of this star. Recorded observation shows that at about the 20th of July the polar distance of β Hydri does not change.

The polar distance of β Hydri between January 1st and the end of July will have increased by the length of the arc U N, which measured off scale gives slightly more than 51″. Recorded observation gives the increase in polar distance from this star, between July 20th and January 1st, as 51″·2.

The other changes in polar distance, and also the changes in right ascension, as demonstrated by this curve, will be found to agree with observation.

The southern star σ Octantis is plotted, as regards its direction, on the diagram. This star, it will be seen from the diagram, increases its polar distance until the end of March, when the line from the star to the pole at Q is at right angles to the arc then traced by the pole. Examine the "Nautical Almanac," and the same facts will be found recorded, as having been found by observation in the Southern Hemisphere.

When the pole is at W, on October 1st, the pole is moving at right angles to the arc joining the pole and the star; consequently the polar distance of the star at that date will not vary. It is recorded, in the "Nautical Almanac," that the polar distance of this star does not vary at that date.

From these results, and those derived from every other star near the poles, it is found that the two curves given above are the correct curves apparently traced by the poles

annually, and we can obtain from these curves even more accurate results than can be obtained by years of wearying observation at hundreds of observatories.

That which makes the problem at first sight somewhat complicated is, that whilst this annual rotation displaces the poles of diurnal rotation, the same annual rotation will not displace the plane of the Equator; consequently the plane of the Equinoctial would still cut the Heavens in the same great circle, no matter whether one rotation occurred round the poles of the Heavens or round two other poles distant 20″ from them, and on the same meridian of right ascension.

That the centre of gravity of the Earth does not and cannot coincide with the centre of the Earth is a problem which has never yet been investigated by astronomers or geometricians. That so slight a variation of the position of this centre of gravity as 2100 feet could produce such singular results as those demonstrated in this paper has also escaped observation. That two curves could be constructed by aid of which the changes in polar distance of stars near the pole could be measured, and the changes in right ascension of every star in both hemispheres demonstrated, is certainly a fact of some importance.

To prevent any enquiry, by suppressing a paper on this subject, is a proceeding scarcely consistent with a love of truth, or a desire for the advancement of true science.

The changes found in the zenith distance of stars were first discovered by Bradley in 1725: he states, in his paper in the "Philosophical Transactions" (1728), that he at first thought that the changes might be accounted for by Solar Nutation, but *having failed to find any movement of the Earth which could account for the observed facts*, he attributed the changes to a combination of the velocity of light and of the Earth's movements in space, and called the cause "*Aberration.*" With the permission of the Editor of this Journal I will shortly give a paper calling attention to this theory of Aberration, and comparing its value as a supposed cause with the facts resulting from the centre of gravity of the Earth not coinciding with the Earth's centre.

II. THE SOURCE OF ELECTRIC ENERGY.

By Charles Morris.

(Concluded from page 468.)

ELECTRICITY, under our hypothesis, is atomic heat. The constituents of molecules are affected differently by motions, these diverse conditions existing at the poles of the molecules, and existing separate from the movements of the molecules as wholes, precisely as these molecular movements exist separately from those of masses as wholes. This effect, as we have argued, results from the influence of similarly disturbed molecules or of molecules of different tension. If now the positive pole of one molecule vibrates to or combines with the negative pole of another, and the polarising force ceases, so that they can obey their local tendencies, what will result? The new molecule, being unaffected from without, forcibly regains the vibratory pitch in accord with its tension. This tendency affects the special atomic vibrations, which are equally above and below the normal pitch. They combine to reproduce the intermediate pitch, and thus their energy becomes heat vibration of the molecule.

Every molecule, as already stated, resists in some measure the polarising influence; and as the effect of this influence is a new distribution of the motive energies of the molecules, these become less and less forcibly disturbed outwardly from the battery. The outward pole of each molecule, whether it be negative or positive, has an excess of electric energy over the inward pole of the succeeding molecule. The sum of these excess energies must just equal the energy of the chemical action in the battery cell, ere the current can pass. And as it is this excess energy which becomes heat in the circuit, it follows that the heat produced is just equal to that necessarily arising from the chemical action. As the heat of the new-formed molecule is produced by the combination of the positive and negative vibrations, this excess of energy of one vibration over the other becomes excess heat over that possessed by the molecules before induction, and in this manner the energy of chemical action is distributed around the circuit. In good conductors the polarisation is almost

complete, and there is little heat production.* In poor conductors it is imperfect, and the excess polarisation of one molecule over the succeeding one becomes excess heat.

One cell produces negative disturbances outwardly, the other positive. These are both distinct forms of energy, and in no proper sense is one an excess and the other a lack of energy, though they may have special differences in their vigour and mode of action. But neutralisation takes place simultaneously in the two opposite directions around the circuit, the negative flow from one cell neutralising the outward positive in essentially the same manner as the positive flow from the other cell neutralises the outward negative. Probably when particles are torn off, and pass from pole to pole, it is in consequence of this opposite action of energies. And the heat which appears in this case doubtless arises from excessive resistance.

In the analogous case of contact between two oppositely charged static conductors the result is essentially as above. The positive energy of the one induces positive energy in the second; the negative of the second induces negative in the first. We may therefore view the molecules of the two conductors as vibrating at three diverse rates—the normal heat vibration, and the two abnormal electric vibrations, equidistant in pitch above and below the normal. It seems probable that these opposed efforts would combine to produce an intermediate normal vibration, the electricity being thus converted into heat. But in case either the positive or negative be in excess of the other, it does not follow that the resultant vibration will be above or below the normal. For this normal vibration is forcibly regained by the molecule as soon as the disturbing influence is removed, and any excess of electric energy continues to exist as atomic vibration. Even if it affect all the atoms of the molecule alike, it exists as an energy in discord with the normal vibration of the molecule, which possesses simultaneously two diverse vibrations—one normal, the other abnormal; one heat, the other electricity.

The views here taken as to the intimate relations which exist between the molecules of contiguous surfaces are far from telling the whole story. Still more extended relations

* In the case of the whole circuit being made up of good conductors the resistance might fall much below the polarising force. In this case only a small portion of the energy would appear as heat in the circuit, and the remainder must appear as heat at the point of chemical action. Only a portion of the energy would be needed to overcome the resistance to polarisation, and only that portion could become heat in the circuit.

exist, and every molecule is tied to every adjacent molecule by close ties of affinity. The tendency to produce conformity of molecular condition, to which we have ascribed the production of electric phenomena, goes further, and yields a resistance to every change in the motive conditions of one substance which is calculated to destroy its harmony with the motive conditions of adjacent substances. To this principle are probably due certain other effects, which are known as current induction and magnetic induction. Suppose, for instance, that two aggregates of molecules have produced their full effect upon each other, in accordance with their relations of position and constitution, and that now some new and special motive condition be given to the molecules of one of the masses. What will result? Their relations of condition will evidently be changed, and a new conformity must be established between them. Yet it seems equally evident that a resistance to this change in condition will be exerted, the two sets of molecules striving to preserve their former relations. There is a principle of inertia here displayed, and the new motion added to the one is partly prevented by, and in the same degree imposed upon, the other. There is a general principle of resistance to such changes, such as the movement of one body while the other continues at rest, or a new movement of the molecules of one while those of the other are undisturbed. And this principle of resistance produces very marked results.

If, for instance, two wires be placed in close relations of contiguity, an influence is at once exerted by each upon the other, and a certain conformity of condition established between their molecules. But if, now, one be made the conductor of an electric current, every phase of the establishment of this current will be resisted by the molecules of the second wire, and the molecules of this second wire will be forced into new relations of conformity with the changed conditions of the first. The establishment of the current is preceded by an inductive action. This is resisted by the second, and produces an opposite induction upon the second. The positive and negative polar conditions in the first are met by negative and positive polar conditions in the second. This condition in the first is followed by the current flow of positive force in one direction and of negative in the other. But this, too, is resisted. The positive poles of the molecules of the first are attractively related to the negative poles of the molecules of the second. When these positive poles of the first move forward they are retarded in their movement by the negative poles of the second, and drag these forward to

the same extent that their own movement is hindered. In like manner the movement of the negative poles of the first is hindered, and causes a like movement in the positive poles of the second. This action is followed by electric neutralisation in both wires, and must cause in the second an electric current in an opposite direction to that proceeding in the first. To the exact extent that motive energy is taken from the first it is given to the second, and the electric current in the second is the exact equivalent of that hindered in the first. The chemical energy has a greater sum of resistances to overcome, and must be more vigorous ere the current can pass. Yet this effect is only momentary. When the electric current of the first has become fully established, the hindrance of the second becomes ineffective. The condition of the first has been changed, and the second has entered into new relations with it. And a reversal of these new relations is resisted as vigorously as was the change in the primary relations. The cessation of the current experiences a hindrance from the second wire equal to that of the formation of the current. As the cessation of the current is equivalent to a backward flow of electricity, its resistance by the second wire produces a forward flow in this. Thus a return to the original relations of the two wires is accompanied by an action in the second equal and opposite to that caused in the loss of the original relations. Any partial change in the strength of the current necessarily produces similar effects to those of the complete formation or cessation of current, for each increment of current acts upon the conducting wire as though it were otherwise unaffected. And also any variation of distance between the wires strengthens and weakens their relations of mutual influence, with the accordant current effects.

If there be no second wire this principle of resistance to change manifests itself between the molecules of the primary wire. For these molecules are really independent, except so far as their mutual influence goes, this influence differing from that between the molecules of two separate wires of the same substance only in being more vigorous and less exposed to exterior substance. There is, therefore, a resistance to change of these molecular relations, possibly between the interior and surface molecules, since these surface molecules are to a certain extent affected by exterior influences. Thus, if there be no second wire, all the effects of induction are displayed in the first, through a principle of resistance to change exactly analogous to that of the former case.

As to the somewhat similar results of magnetic induction, we can only say that they display still another indication of this intimate connection between all molecules, and the effort of the molecules of each substance to hinder any change in their relations to each other, or to those of another substance. But the character of this resistance and the cause of its effects cannot be understood without a precise idea of the mode of magnetic motion. As to this we are still at a loss. The theory of Ampère, that magnetism is a result of closed electric currents circulating in parallel directions around the molecules, will not stand the test of our present knowledge of electricity. A continued electric current is impossible without there be a continued yielding of energy. Static electricity is fixed in position in fixed conditions: it only moves or varies when the shape or extent of the surface, or its relation to other surfaces, is changed. And this movement is in no sense a temporary, much less a continuous, circular current. Dynamic electricity is not a continuous, but a series of rapidly succeeding currents. For every increment of current there must be an increment of energy set free by some chemical or other agency. The idea of electric currents circulating continuously around molecules is therefore entirely at variance with the known action of electricity, and with the principle of the conservation of energy.

It is possible, however, that there may be a continuous circular motion of another kind, for atoms may be rotating spheres, disks, or rings of ethereal substance, their central attraction being a result of this rotary motion, and their exterior attractions also a result of the same motion. In the latter case the attraction would be polar, being necessarily strongest in the line of the axis, and changing to repulsion between two atoms whose rotation was in opposite directions. In a mass in which the atomic rotation was largely in one direction magnetic force would appear, and all its variations might result from the various relations of this condition between the atoms of separate masses. It is also possible that the influence of a vigorous rotary motion, like that which effectively, though not actually, exists in the inductive coil when conveying an electric current, might, by its attraction, force the atoms of another mass to assume such positions that their rotation would agree with that of the current. In such a case magnetic energy would display itself.

Reversely, the rotary energy of a magnet is resisted by the molecules of a coil into which it is introduced; and this re-

sistance produces a reverse electric current. But to understand the exact relations between the molecules of the magnet and those of the coil a more definite acquaintance with the true character of magnetic motion would be requisite. It is, doubtless, a resistance to the magnetic rotation analogous to that which displays itself in the case of current induction, but one which cannot be properly comprehended without a clear idea of the character of the centripetal motions of molecules and atoms, and their mutual attractive relations.

And as the production of harmonious relations between the molecules of a coil and of a magnet is accompanied by the formation of a momentary electric current, so in the case of a substance rotating near the poles of a magnet there is a constant change of relations, since the rotation constantly brings new sets of molecules into propinquity to those of the magnet. There arises, therefore, a constant electric current, made up of a continued series of temporary induced currents. It is not the internal motions of the magnet, but the rotary motion of the other mass, which is here converted, first into electricity, but finally into heat. The magnet, in fact, seems to exert an attractive resistance on the movement of the other body, which, under some circumstances, results in an immediate conversion of this movement into heat; but where the substance is an unbroken electric conductor, it yields first an electric current, and finally heat. This electric current shows that the magnet not only exerts an attractive resistance to the motion, but that it also produces an electric disturbance in the molecular energies. The result therefore is not increased heat-vibration, but electric neutralisation, and the phenomenon of the electric current.

Electricity is principally concerned with the relations of solid and liquid surfaces. It produces little other effect upon gases than induction. Light and radiant heat are concerned with the relations of solids or liquids to gases, or perhaps only to that ultra-gaseous form called ether. Therefore, although the innate character of this mode of motion may be the same, its vibratory pitch may widely differ, and the conditions of the substance which it affects are so widely different from those of electric substance that we cannot apply to these two series of phenomena the same methods of investigation. The movements of static electricity are towards the surfaces of a conductor. When these surfaces are accordantly electrified the energy ceases to be transmitted, and becomes truly static; but if the conductor were infinite in extent it would take an infinite period to produce this surface accordance, and the electric movement would continue inde-

finitely, or until reduced by resistance to heat. Such is the case in light transmission. Its conductor is infinitely extended. Its movement is therefore continuous, and light transmission can only cease by its gradual conversion into heat, or into some other mode of motion. Yet it is not difficult to produce a condition of radiant action somewhat similar to that existing in a charged electric conductor. For if we have a closed room bounded by reflecting surfaces, and with a source of light in its centre, there is no evidence of the accumulation of this light, however perfect the reflection may be. Each increment of the light may suffer a series of reflections, but these are instantaneous, and every successive portion of light emitted immediately ceases to be visible. When the light is quenched, or the light-yielding chemical action hindered, the light instantly disappears. What has become of it? It has not escaped from the room. It has not sunk into the wall. It has only partly been converted into static heat. Where is the remainder? Energy cannot die out. It must continue to exist in some form. If not light, or heat, or mass motion, what is this form of energy? May it not exist in a condition resembling static electricity? It is possible that the induced light energies of the interior substance of the room may be neutralised, like the induced electric energies within a charged conductor. The vanished energy may exist on the surfaces of the room precisely as static electricity exists on the surface of a conductor. No trace of this energy could possibly be discovered from the interior, on account of the interior neutralisation, on the same principle that prevents our finding electricity in the interior of a charged conductor. Nor is it possible for us to test it from without the surface, as we can electricity. There are some possible phenomena in this connection which we cannot discover. There is no evidence of a movement of light force when the surface of a room thus charged is increased by opening it into another dark room. But the action here is an induction, not a current, and would not be likely to affect the eye. Nor can we perceive any trace of outward induction of this energy through the confining walls. And yet it is not quite illogical to argue that light and electricity are like modes of motion, and that the reason we cannot discover every phenomenon of the one in the other is simply because we cannot subject them to the same processes of investigation.

If there really exists such a similarity between light radiation and electric radiation, the action of light would not resemble the movement of an electric current through the

connecting-wires of a battery. Its true analogy would be to the movement of static electricity through the interior of a conductor, the effort not being towards neutralisation, but towards surface change. And in this case the infinite extent of the conductor causes an infinitely continued movement of the unabsorbed portion of the energy. All the spheral orbs of space may really occupy interior relations to the conductor of cosmical radiance, and thus be incapable of light electrisation.

The great diversity in the pitch of light-vibrations may arise from another cause. There is incessant change in the relations of molecules by which these radiant vibrations are produced. The molecules now separate from each other, now come into contact. Their relations of distance, and thus of mutual polarisation, are constantly diversified. And if the radiant vibrations result from mutual action under these diverse relations, they might possibly differ very greatly in pitch, waves of different pitch succeeding each other with great rapidity. This idea, of course, is but conjectural, and advanced as a mere hint at the possible cause of these variations.

III. HYLOZOISM *versus* ANIMISM.

By C. N. Communicated by Dr. R. Lewins.

"God is a blank sheet, on which nothing is found but what we ourselves have written."—Luther.

I MUST beg to express my deep sense of obligation to Mr. Barker for his ingenious criticism, in your July issue, of the article entitled "Hylozoic Materialism," which I contributed to the June No. of this Journal. No one can do me a greater service than by most rigidly and severely scrutinising the "weight and measure" of my arguments; and I am not only willing, but anxious, that they should be submitted to such a test.

I need hardly say that the word "Hylozoism," being derived from the Greek *Hyle*, matter, and *Zoe*, life, signifies the doctrine of the inherent and inseparable vitality or

energy of matter. So far from being a new or unintelligible compound it is constantly used by Cudworth, in his great work on the "Intellectual System." It has been since so familiarised by other thinkers that the term will be found in any complete dictionary of our language.* Life, in its simplest and broadest sense, may be defined as potential activity, accompanied or not by the powers of reproduction and sensation ; and it is a firmly established axiom of contemporary science that such life or activity belongs to every atom of the material universe. Yet, though the theories of ancient deductive philosophy are reduced by the inductions of modern physics to definite formulæ, Hylozoic Materialism is essentially identical with that of Democritus, Epicurus, Lucretius, and of all, ancient or modern, who have rejected the supernatural element from their *rationale* of existence. It is not surprising that so simple a generalisation should appear "wild and extravagant" to those who find it easy to repose their faith in spiritual mysteries ; for the mind of man is always more strongly attracted by complex fictions than by plain facts. Not till he has woven and rejected or worn out successive garbs of fable can he bear to gaze upon the naked truth ; and this explains the hostility which Materialism has encountered from many grand and subtle intellects, who have chosen to deck Nature with false jewels instead of seeking docilely for her native treasures. It is true that the ignorant have displayed equal antagonism, but their ignorance has been imitative, not primitive, and they have only followed blindly in the wake of their betters. Children and savages are with difficulty made spiritualists, though their instinctive, necessarily empirical, Hylozoism is complicated by the influence of fear, wonder, and of that natural tendency to personification which is the parent of poetry and religion. In the same way men of science, even though they may recognise the fallacy of Dualism, are often too apt to literalise metaphors and regard abstractions as entities. Consciously or unconsciously they elevate Force, which is but a function, to the rank of an agent ; and of this erroneous conception I find an apposite example in Mr. Barker's letter.† He says, on p. 428 ("Journal of Science" for July), "But will C. N. contend that nothing has a real

* In connection with this theorem of "Life and Mind" the articles "Cudworth" and "Animism," in the new edition of the "Encyclopædia Britannica," are worth the perusal of those interested in the subject. Liddell and Scott's Greek and English Lexicon may also be turned to with profit. Hylozoism is the exact equivalent of Non-Animism, the antithesis of Animism.—R. L.

† As a further example of the confusion still existing in the scientific mind on this subject, see Prof. Tait's Lecture, a few years since, at the Glasgow

existence but that which is cognisable by our senses? Then he must give up his belief in the existence of almost every force in Nature,—*e.g.*, magnetism or electricity, for he cannot see them; indeed he cannot *see* the force in his own arm, he can only *infer* it from its visible effects; *or*, from conscious feeling in his mind that he possesses it." I accept the illustration: for the forces of magnetism and electricity, of heat, light, gravitation, and muscular motion are not independent and separable entities, but special forms of that universal activity which is an inalienable function of Matter. I believe in the effects which I see and feel, not in a hypothetical and wholly superfluous "cause." In the next sentence I find the assertion that "the very fact of our consciousness that we can, at will, exert force upon matter, proves that there is something in our bodies superior to matter, and therefore necessarily distinct from, however associated with, matter." I fail to understand the cogency of this reasoning. It seems to me that the phrase "superior to matter" begs the whole question in dispute; for if, as I contend, our physical structure is capable of thought and sensation, it possesses the attributes usually assigned to "spirit;" and thus complementary qualities, usually supposed to be divided between two entities, are united in one. Except on the principle that half is more than the whole, I do not see how a perfect being can be inferior to an imperfect one, and the very word "immaterial" implies defect and limitation. The fact that "we can, at will, exert force upon matter," does not prove the existence within our bodies of an "*anima*" or immaterial principle. One stone attracts another; is it therefore *animated* or inspired by some essence superior to stone? The brain acts upon the body, of which it is a part; but this, like the action of wind upon water, of the sun on a planet, is the effect of a relation between matter and matter, not between matter and "spirit."

Unless it can be shown that certain nervous and muscular motions are caused by conscious volition apart from organisation, there remains no function for the soul, nor any method by which it can manifest itself in the outer world. If "will" be destitute of dynamic power it is a non-entity and illusion; and this is the plain teaching of modern Physiology and Pathology. That motion, even when apparently intelligent, may be unaccompanied by thought or

Meeting of the "British Association for the Advancement of Science," in which he rejects, most summarily, Dr. Tyndall's conception of "Force," as enunciated in the latter's Presidential Address at Belfast.—R. L.

sensation, and due to purely physical causes, is clearly proved by the phenomena of reflex action in paralytics and in decapitated animals; and if such movements, originating in the spinal cord, are automatic, we can hardly assign a different character to those manifested by the cerebral hemispheres, since the mode of action of all the different nerve centres is essentially the same. It is surely far more credible and rational that consciousness, like other bodily functions, is evolved by complexity of organisation, than that one portion of the nervous system is self-working, while another is subjected to the constant interference of an indwelling spiritual power. The *vis insita* of matter (which etymologically means *indwelling*, but practically means *inalienable* force) supplies the place of the Divine afflatus, and affords, in the strictest sense of the phrase, a logically sufficient "cause"—*i.e.*, a *rationale* reducing apparently anomalous phenomena to a familiar category. We know that increase of weight by calcination results from chemical combination with oxygen, or other supporter of combustion, and therefore dismiss the old theory of a separable levitating factor (*phlogiston*), thus refusing to "assume two principles where one is sufficient." The dualistic hypothesis of matter and spirit is only a wider generalisation of the pre-Lavoisierian fallacy. I do not, of course, deny "what is called a chain of causation," *where it can be discovered;* but where there is no trace of such a chain neither Science nor Philosophy is authorised to assume its existence.

No doubt "the worst and most absurd errors are often"—I would say *always*—"the corruptions or exaggerations of truths." But in such cases the evidence must be stronger on one side than on the other; the reality must be more strongly supported than the simulacrum; and until I am informed in what respect the evidence for the existence of fairies, goblins, and witches fall below that for the existence of the soul, my argument is untouched. We know that men see visions and dream dreams, that their thoughts and feelings are capable of higher development and of more indefinite range than those of the brutes; and truths such as these have been corrupted into the errors of Dualism.

Mr. Barker somewhat misapprehends the significance of my illustration drawn from the phenomena of isomerism. I wished to show that as the same components might combine in the same proportions to form an odorous or an inodorous, a hurtful or a harmless compound, so the same particles might unite in a sentient or non-sentient organism. In the former case, as Mr. Barker himself observes, no one postu-

lates the exit or entrance of a spiritual poison or odour; why then superadd a "soul" or thinking essence in the latter? I pass by the assertion that volition "cannot be reasonably ascribed to mere matter," only remarking that no property whatever can be "reasonably ascribed" to a hypothetical phantom like "spirit." That animal life is the outcome of certain chemical processes, upon which its energy and continuance are entirely dependent, appears to me as certain a proposition as that the combustion of a candle results from the combination of its carbon and hydrogen with the oxygen of the atmosphere. The two cases are strictly analogous; but the oxidation which sustains and vivifies our animal frame takes place under more complex conditions, and kindles a slower non-incandescent fire.

Mr. Barker regards "sensation as belonging to (not proceeding from) the nervous tissue; but perception of that sensation as belonging to the living *anima* associated with it, exclusively." The distinction between "belonging to" and "proceeding from" is not very clear; and it is evident that perception, emotion, and thought are simply the special sensations or functions of the grey vesiculo-neurine of the encephalon, upon the healthy condition of which their sanity depends, just as sight depends on the eye and hearing on the ear. If matter be simply an inert machine, which must be kept in good order that it may obey the impulse and behests of its ghostly *Archæus*, how shall we account for the fact that a merely physical stimulus—as of alcohol, opium, &c.—may suffice to change the whole current of thought and feeling? Surely this is a case of the fiddle playing on the musician!

I have reserved for the conclusion of this letter a few remarks on Mr. Barker's theosophistical speculations, which, as outside Reason, do not properly fall within the scope of a scientific argument. He will see, by a reference to my article, that the quotation from Dr. Lewins' tract, "Life and Mind," ran thus:—"*The question of* the *anima mundi* and the *anima humana* is, at bottom, one and the same." By leaving out the first three words he has incorrectly construed the sentence into the admission of the existence of a cosmic and human soul. All energy is of course an attribute of some being,—*i.e.*, of something which exists; but we need not therefore assume that this being is personal or conscious. Intelligent agents exercise energy; but this does not involve the converse proposition, that all energy must originate in a conscious agent. An "Infinite Mind" giving "existence to finite minds" must be limited by its own creations, and

therefore be at once infinite and finite. Is not this an unthinkable paradox? If there be an *Omnipresent* Deity, nothing else can have any real existence, and he must be the noumenon of which the Universe, subjective and objective, is the phenomenon. It signifies little whether this one and indivisible Reality be spoken of as God, Force, or Matter (though the last term is preferable, as being the simplest and least liable to misconstruction), for *to us* it is practically non-existent. No man can transcend his own Egoity or individual subjective Cosmos, of which his brain is the sole proplasm, though he may people it with Jehovah and his hierarchy of angels and archangels, "good" and "evil," with the humanised gods of Hellas, with the New Testament Trinity, or with the saints and witches, goblins and fays of the Middle Ages. Neither reflection nor imagination will enable him to get "behind" Nature,—itself only a mental abstraction,—or penetrate to the substratum of his own being. If he believe in an Omnipresent God, he is, as I have shown, logically compelled to Monism; if not, he rejects "Revelation," and certainly will find in Science and Reason no foundation for Dualism. From this dilemma he cannot escape, and should esteem himself happy that "salvation" or *health*—the *mens sana in corpore sano*—does not depend upon the attainment of the unattainable, but is placed within the sphere of his own knowledge and capacity.

PS. I regret that I had not observed the correction of the statement respecting vegetable protoplasm in Mr. Barker's paper.

IV. A GEOLOGICAL IDEA OF LORD BACON'S.

By Dr. O. Reichenbach.

LORD BACON, not yet knowing of Australia, already drew attention to the southward directed points of continents as probably due to a common cause in the evolution of the Earth. The hint has been of no value to Science.

Lord Bacon was not a physicist, and not at all a mathematician, but surely a man of great philosophical instincts. As Englishmen may be proud of this countryman, some scientists amongst them may perhaps feel disposed to attentively read an article which shows the causation in the position and distribution of these points.

A planetary mass divided into planets, similarly as did Biela's comet.

The earth turned off the moon and rings, as Saturn has got them.

The rings returned to the earth, and spread out into envelopes.

Rings away from the planet are disturbed by sun and moons, so are envelopes in contact. A distant ring revolves, and envelopes in contact continue to revolve. Their slackened rotation generates friction and heat, which depend on the relative weights, densities, molecular conditions, and stages of evolution.

The polar axis is not only shorter than the equatorial, but both axes have a long and a short branch. Measured meridians confirm this. This means unequal density of the hemispheres; consequently an unequal distribution of sea, west and east, south and north. The eccentricities of both axes are the same; they co-determine the mutual action of the inner planet with its envelopes. South and west are the more condensed hemispheres; they exceed north and east in the mass of sea, not only in proportion to surfaces of sea, but they possess by a regionally greater depth of sea a further excess of water, amounting for each of the respective hemispheres to 1-29·78 of the mass of the sea. 1-29·78 of the axis of the orbit is the difference of greatest and least distance of earth and sun. The eccentricity of the polar or equatorial axis is 1-3546 the square of the eccentricity of the orbit. The sea, in the mean 15,180 feet deep, is 1-3546 of the mass of the earth.

The fluid remnants of descended rings of catastrophic rains, or downpours of solids, liquids, and gases, during periods of earthquakes, electric commotions, and magnetic constitutions, are the sea.

The sea is an envelope decomposed into four rings,—two equatorial, two polar.

The solid envelope has a less density than the mean one of the earth. It is separated from a nucleus by a mere elastic stratum, becoming locally solid, liquid, and gaseous. The envelope thus may slide on the nucleus.

The weight in motion of the sea rings acts tangentially on

the envelope; it moves it, and produces friction and heat in the interstratum, during progressive condensation interrupted by expansion. This internal heat keeps the envelope malleable and pliable, and the tangential force of the sea lifts and folds a portion of it into continents equal in weight to the sea. The sea gets imbedded between the folds, and raises—by arrested motion and an excess of specific gravity—land above its level to a mean height of 1018 feet, 1-14·78 of its own mean depth.

As the crystal has its angles and faces as results of a past, thus has the earth its features as gradual results of the tangential work of the sea on the envelope, and *through it* on the interior.

No law is absolute. The law of A is always interfered with by that of B.

No relation of figures or features I give I claim to be absolutely correct. Carping at my figures may be sometimes easy without being wise.

Poles, equator, polar and tropical circles are features bounding zones which are the means for less regularly shaped meteorological zones.

The arc from the pole to its circle is 23° 28′; the remaining arc to the equator is 66° 32′. These arcs are 1 : 2·83. The extent of land to sea is 1 : 2·83. The density of the water in the sea to that of the envelope, and of the land *to the mean depth of* 1518 *feet from sea-level*, is 1 : 2·83. The masses of the water and the folded land are equal. That water contains salts and land rises above the sea are modifying details.

23° 28′ goes twice into 66° 32′, or thrice into 90°, leaving a remainder of 19° 34′. In all 2·83 and 3·83 times to complete the 3 and 4 we have to borrow 3° 52′ beyond the equator. The polar zones are like stones alternately thrown into the halves of a pond—they produce waves.

The centrifugal action of each hemisphere has its mean limit in the equator for the whole earth,—not for the sea, envelope, or nucleus separately. The 3° 52′ are nodal bands between waves 19° 14′ wide, propagated from hemisphere to hemisphere.

The sinus of an angle of 3° 52′ is 1-29·78 of the radius. There are connections. The inclination of the axis on the orbit and the eccentricity of the orbit are conflicting and compromising subjects of sovereign gravity.

If the density of the earth had been equal north and south, not west and east, and the equator had coincided with the orbit, and the relative densities of sea and envelope had

been the present, the folds ever raised laid bare and submerged, never permanently constituted, would have presented a transitory appearance whose image we may trace in the equator, where the effects from either side consequent on centrifugality tend to balance each other.

Three land segments traverse the equator. This is analogous to the perturbations suffered by the moon. The first one commences on the west coast of America, between the deepest waters in the West Atlantic and East Pacific, at Pr, the pericentre of the nucleus in the equator. Counting meridian Pr 0°, segment Pr occupies 31° 20′. Segment Af, commencing with 90° E. long., again occupies 31° 20′.* Segment Ap we meet in 180 E. long.; it extends from Sumatra beyond Gilolo to the east of Waggiou, through 31° 20′, not entirely occupied by land, but the segment is well defined by continental islands west and east. We thus have in the equator land formation $31° 20' \times 3 = 97°$, to the remaining 266° of ocean 1 : 2·83.

Globe I. shows the three segments from pole to pole. The land within is 0·512 of all land; the remaining 0·468 are around. The land of two segments is partly contiguous; the boundary corresponds to *geological and organic* characteristics. The middle segment, with the greatest mean elevation, is entirely opposite to ocean.

This is the prototype which always tended to form, but never formed; like an embryo contending to develop one form, but by interference bound to adopt another.

Folds from pole to pole would be barriers against their cause—the revolution of an ocean and the circulation of ocean rings *parallel* to the equator and a coinciding orbit.

Any outside body which disturbs equality of density and of distribution of weight to the sides of this equator produces a perturbation in latitude which causes the ocean to *break through* the folds rising perpendicularly to the equator, makes the equator inclined on the orbit, maintains the circulation of the ocean round the earth by engendering polar streams, and allows the poles to develop themselves to an oscillatory permanency. It allows the earth animal to live; its blood circulates, its heart beats: when the ocean stops, the corpse descends to the sun, which finally also dies.

The continents have been tangentially folded by the sea, and perpendicularly lifted by the expansive powers of its substances present and penetrating below the envelope.

The inequality of density and mass has been developed in

* Globes as referred to may be seen at the South Kensington Museum.

south and north symmetrically with west and east. The density of sea to land is 1 : 2·83; the extent of land to sea is 1 : 2·83; the land south to north is 1 : 2·83 (altered by tertiary reasons into 1 : 2·73). The sum of the parallels of 45′ cuts 1 land to 2·83 sea; the land arc at the south is to that at the north as 1·01 : 11·07, as the height of the polar zones to that of the remaining sphere.

A planet or moon does not uniformly describe an ellipsis, but a chain of waves with varying velocities. Thus is the motion of ocean rings round an eccentric planet perturbed in longitude and latitude. From the first these rings must have accommodated themselves to the continents they raised.

The circulation of the ocean, and with it the vibration of the land, has been decomposed into four intertwining rings, two equatorial, two polar; and their normal mean orbits, or lines of intensity, from which the water is made to deviate, present, drawn through sea and land, four great curves, whose apsides we find by reasoning and by the distribution of sea and land.

We had as equatorial pericentre of the inner earth, Pr; as apocentre, Ap. The equatorial lines of intensity of sea and envelope, at their mean,—that is, at absolute surface,—have their pericentres 23° 28′ north and south on meridian Pr, and their apocentres on Ap; they are tangent to the tropical circles. The polar lines have their pericentres in V and I 90° west of Pr, and their apocentres at L and M on the polar circles.

V coincides with the region from where the tides start. L is the Maelstrom of old fame; I falls into Behring's Straits; M into nameless parts. From L to S the arctic circle crosses 180° of land. The sum of the polar circles crosses 360° of land and 360° of sea. The antarctic circle $(\sqrt{2{\cdot}83})^3 = 4{\cdot}78$ of ocean to 1 of land; the arctic the opposite.

West of the meridian circle, Pr, Pn, Ap, Ps (Ps the south).

In the North Pole there is 1-27th of all land more than south of the equator; but when we lay through Pr Ap a circle anywhere between 10° 42′ to 11° 59′ from Pn towards I, it divides the land 1 : 2·83. A circle laid through Pr Ap, south of I on meridian S V, anywhere between 34° 12′ to 55° 48′, divides the land $1 : 2{\cdot}83^2 = 1 : 8{\cdot}008$.

The sea which—less dense than the earth—stays behind in rotation will try to break through the prototype where gravity in the equator is absolutely greatest. The barriers

will be folded in latitude. The break will be driven from that hemisphere where gravity and the mass of the sea are greatest towards the other; from round Ps, where gravity on the earth is greatest, and the sea is deepest towards Pn. The interval between folds will be moved from the equator towards the north.

Globe III. thus shows that the segment Pr has been divided into two equal halves by the reflux of the sea. These halves are connected by an isthmus. Isthmuses, islands, peninsulas, certain regions, are the results of conflicting proportions; two or more contradictory conditions must be compromised; interference waves, supplements, are the consequence.

If a mass of liquid, equal in extent, depth, and density in the respectively equal parallels, moved in retrogression and progression, parallel with an equator coinciding with the orbit, striking the solid according to the apsides of the parallels first in the pericentric meridian Pr, the forming folds would coincide with the meridian. But when the sums of striking forces become unequal to the sides of the equator the fold must become inclined to meridian Pr, which itself will not be exempt from motion over the nucleus reacting by elasticity.

The inequality of forces moving the fold to the incline is represented by two equal forces acting in opposite senses, gradually moved from the points Ps and Pn towards Pr, and by the plus of force consequent on the greater condensation, and consequently greater mass of liquid in one hemisphere, which causes this liquid, having a depth beyond the mean one, to press, move, and fold from Ps towards Pn, causing an increasing reaction of folding from Pr back towards Ps.

The varying differences between the equal forces and the plus determine the quantities and senses of absolute sliding of the envelope V, and its single strata over the nucleus. It is the inequality of masses and distribution of forces in any pair of hemispheres, and the difference of inner attraction of solid and liquid envelope, that is of elasticity, which determines the size of folds and their subdivision, and opens the passage for a complete circulation of the sea.

The polar zones contain land to sea 1 : 2·83; the tropical zones contain—

$$\frac{1}{29{\cdot}78} + \frac{1}{287} + \frac{1}{3546} = \frac{1}{27}$$

of all land less than 1 of land to 2·83 of sea; the middle zones so much more.

By the overweight of the sea round Ps, consequent on a greater regional condensation of the nucleus by external influences, the envelope at the south has been smoothed away from Ps, and raised and plicated towards the north. The mass above the lower zero level of land and sea has been increased at the north; the interstratum, having been heated, expanded, made less dense and more elastic, by the fall, penetration, and internal heat effect of water from the south.

Folds are the accumulated remainders of continued oscillations: the world is built up by oscillations, all referable to gravity.

I directly connect the waves of sea and land, but a comparison will more easily be appreciated. The number of vibrations of blades of equal material and dimensions, length excepted, are in equal times inversely as the squares of these lengths. Imagine land and sea formed into blades equally broad and thick, and fixed at respective points, poles, they will be in length $1 : 2{\cdot}83$. The sun is the bow setting them in vibration.

If sea and land were of equal material the frequency of vibrations would be $2{\cdot}83^2 : 1$, but the land is $2{\cdot}83$ times more dense. The vibrations of chords or blades of equal dimensions, but different material, are, in like times, in frequency inversely as the square roots of the densities; the rotation becomes $(\sqrt{2{\cdot}83})^3 : 1 = 4{\cdot}78 : 1$.

Both these and all further developed undulations will be represented in land and water,—the one directly, the others by induction through the other element. Thus the land south to north is $1 : 2{\cdot}83$, and the extreme division of land by hemispheres is $2{\cdot}83^2 : 1$. As undulations produce heat in air and sounding-board, they produce it in land and water.

Globe II. presents the deutotype. It shows the prototypic segment Pr moved to an incline of 23° 28′ to meridian Pr; its basis is tangent to the polar circles in S and M. The motion has been reciprocal with the developed inclination of the equator on the orbit.

Segment Ap is equally inclined; its basis is tangent to the polar circles in V and L. The middle segment occupies the prototypic position; it bars equatorial circulation.

The sum of land inside the segments is to that outside $\sqrt[4]{(2{\cdot}83)} : 1$. The land outside is closely around, with the exception of the antarctic section belonging to segment Pr. On Globes II. and III. surfaces of land outside correspond to equally coloured ocean surfaces inside.

The sections into which these segments have been divided are each composed of an oblong and a triangle, of a large wave crossed by a small one; but circles represent on Globe III. conveniently the mean surfaces and characteristics.

Meridian circle Af passes through L and S. The meridian circle which equally divides segment Af in the equator, equally divides the land belonging to segment Af, and also all land and sea generally. The configuration of the earth seen in the profile of this circle shows the symmetry of the halves.

Segment Pr is divided into four sections; the extremes, the arctic and antarctic, are equal, so are the middle ones. Each extreme is to each middle $1 : (\sqrt{2{\cdot}83})^3 = 1 : 4{\cdot}78$.

The middle sections are connected by an isthmus; the extremes are divided into archipelagos by the ocean rings in their tendency to maintain the circulation of the water complete in the amalgamated senses of longitude and latitude, with separation of retrogressing and progressing streams, of *arteries* and *veins*.

Segment Pr gets not only inclined and divided: it is, together with Ap and Af, pushed north by the 1-29·78 of surplus water by depth round Ps and its zone, the region of absolutely greatest gravity.

The parallel 34° 12′ from Ps divides half the prototypic segment Pr in proportion $1 : (\sqrt{2{\cdot}83})^3 = 1 : 4{\cdot}78$. This is 10° 44′ outside the antarctic circle. The southern point of America is 10° 44′ from that circle.

(To be continued.)

V. ON DIPTERA AS SPREADERS OF DISEASE.

By J. W. Slater.

THE two-winged flies, in their behaviour to man, stand in a marked contrast to all the other orders of insects. The Lepidoptera, the Coleoptera, the Neuroptera, the Hymenoptera no doubt occasion, in some of their forms at least, much damage to our crops. But none of them are parasitic in or upon our bodies; none of them persistently

intrude into our dwellings, hover around us in our walks, and harass us with noise and constant attempts to bite, or at least to crawl upon us. Even the ants, except in a few tropical districts, rarely act upon the offensive. The Hemiptera contain one semi-parasitic species which has attained a "world-wide circulation," and one degraded, purely parasitic group. But the Diptera, among which the fleas are now generally included as a degenerated type, comprise more forms personally annoying to man than all the remaining insect orders put together. These hostile species are, further, incalculably numerous, and occur in every part of the globe. Mosquitoes swarm not merely in the swampy forests of the Orinoco or the Irrawaddy, but in the Tundras of Siberia, on the storm-beaten rocks of the Loffodens, and are even encountered by voyagers in quest of the North Pole. The common house-fly was probably at one time peculiar to the Eastern Continent, but it followed the footsteps of the Pilgrim Fathers, and is now as great a nuisance in the United States and the Dominion as in any part of Europe. It is curious, but distressing, to note the tendency of evils to become international. We have communicated to America the house-fly and the Hessian fly, the "cabbage-white," the small-pox, and the cholera. She, in return, has given us the *Phylloxera*, a few visitations of yellow fever, the *Blatta gigantea*, and, climate allowing, may perhaps throw in the Colorado beetle as a make-weight. In this department, at least, free trade reigns undisputed. It is a singular thing that no beautiful, useful, or even harmless species of bird or insect seems capable of acclimatising itself as do those characterised by ugliness and noisomeness.

But, returning from this digression, we find in the Diptera the habit of obtrusion and intrusion, of coming in actual contact with our food and our persons, combined with another propensity—that of feeding upon carrion, excrement, blood, pus, and morbid matter of all kinds. This is a combination far more serious than is generally imagined. If the fly—which may at any moment settle upon our lips, our eyes, or upon an abraded part of our skin—were cleanly in its habits, we need feel little annoyance at its visits. Or if it were the most eager carrion devourer, but did not, after having dined, think it necessary to seek our company, we might hold it, as is done too hastily by some naturalists, a valuable scavenger. I fear, however, that I have already made too great a concession. So long as very many persons are suffering from disease,—so long as many diseases are capable of being transmitted from the sick to the healthy,—

so long must any creature which is in the habit of flying about, and touching first one person and then another, be a possible medium of infection and death.

Let us take the following case, by no means imaginary, but a generalisation from occurrences far too frequent :—A healthy man, sitting in his house or walking in the fields, especially in countries where the insectivorous birds have been shot down, suddenly feels a sharp prick on his neck or his cheek. Putting his hand to the place he perhaps crushes, perhaps merely brushes away, a fly which has bitten him so as to draw blood. The man thinks little of so trifling a hurt, but the next morning he finds the puncture exceedingly painful. An inflamed pimple forms, which quickly gets worse, whilst constitutional symptoms of a feverish kind come on. In alarm he seeks medical advice. The doctor tells him that it is a malignant pustule, and takes at once the most active measures. In spite of all possible skill and care the patient too often succumbs to the bite of a *mouche charbonneuse*, or carbuncle-fly. But has any kind of fly the property of producing malignant pustule by some specific inherent power of its own ? Surely not. The antecedent circumstances are these :—A sheep or heifer is attacked with the disease known in France as *charbon*, in Germany as *milz-brand*, and in England as *splenic fever*. Its blood on examination would be found plentifully peopled with bacteria. If a lancet were plunged into the body of the animal, and were then used to slightly scratch or cut the skin of a man, he would be inoculated with "charbon." The bite of the fly is precisely similar in its action. Its rostrum has been smeared with the poisoned blood, an infinitesimal particle of which is sufficient to enclose several of the disease-"germs," and these are then transferred to the blood of the next man or animal which the fly happens to bite. The disease is reproduced as simply and certainly as the spores of some species of fern give rise to their like if scattered upon soil suitable for their growth. But flies which do not bite may transfer infection. Everyone must know that if blood be spilt upon the ground a crowd of flies will settle upon and eagerly absorb it. Animals suffering from splenic fever in the later stages of the disease sometimes emit bloody urine. Often they are shot or slaughtered by way of stamping out the plague, and their carcases are buried deep in the ground. But some loss of blood is sure to happen, and this will mostly be left to soak into the ground. Here again the flies will come, and their feet and mouth will become charged with the contagion. Such a fly, settling upon another animal

or a man, and selecting—as it will do by preference, if such exist—a wound, or a place where the skin is broken, will convey the disease.

Again, M. Pasteur has thoughtfully pointed out that if an animal has died of splenic fever, and has been carefully buried, the earth-worms may bring up portions of infectious matter to the surface, so that sheep grazing, or merely being folded over the spot in question, may take the plague and die. Hence he wisely counsels that the bodies of such animals should be buried in sandy or calcareous soils where earth-worms are not numerous. But it is perfectly legitimate to go a step farther. If such worm-borings retain the slightest savour of animal matter, flies will settle upon them and will convey the infectious dust to the most unexpected places, giving wings to the plague.

Now it is very true that no one has seen a fly feasting upon the blood of a heifer or sheep dying or just dead of splenic fever, has then watched it settle upon and bite some person, and has traced the following stages of the disease. But it is positively known that a person has been bitten by a fly, and has then exhibited all the symptoms of charbon, the place of the bite being the primary seat of the infection. We know also, beyond all doubt, the eagerness with which flies will suck up blood, and we likewise know the strange persistence of the disease "germs."

Again, the avidity of flies for purulent matter is not a thing of mere possibility. In Egypt, where ophthalmia is common, and where the "plague of flies" seems never to have been removed, it is reported as almost impossible to keep these insects away from the eyes of the sufferers. The infection which they thus take up they convey to the eyes of persons still healthy, and thus the scourge is continually multiplied.

A third case which seems established beyond question is the agency of mosquitoes in spreading elephantiasis. These so-called sanitary agents suck from the blood of one person the Filariæ, the direct cause of the disease, and transfer them to another. The manner in which this process is effected will appear simple enough if we reflect that the mosquito begins operations by injecting a few drops of fluid into its victim, so as to dilute the blood and make it easier to be sucked.

So much being established it becomes in the highest degree probable that every infectious disease may be, and actually is, at times propagated by the agency of flies. Attention turned to this much neglected quarter will very probably go

far to explain obscure phenomena connected with the distribution of epidemics and their sudden outbreaks in unexpected quarters. I have seen it stated that in former outbreaks of pestilence flies were remarkably numerous, and although mediæval observations on Entomology are not to be taken without a grain of salt, the tradition is suggestive. Perhaps the Diptera have their seasons of unusual multiplication and emigration. A wave of the common flea appears to have passed over Maidstone in August, 1880.

We now see the way to some practical conclusions not without importance. Recognising a very considerable part of the order of Diptera, or two-winged flies, as agents in spreading disease, it surely follows that man should wage war against them in a much more systematic and consistent manner than at present. The destruction of the common house-fly by "*papier Moure*," by decoctions of quassia, by various traps, and by the so-called "Catch 'em alive," is tried here and there, now and then, by some grocer, confectioner, or housewife angry at the spoliation and defilement caused by these little marauders. But there is no concerted continuous action,—which after all would be neither difficult nor expensive,—and consequently no marked success. Experiments with a view of finding out new modes of fly-killing are few and far between.

Everyone must occasionally have seen, in autumn, flies as if cemented to the window-pane, and surrounded with a whitish halo. That in some seasons numbers of flies thus perish,—that the phenomenon is due to a kind of fungus, the spores of which readily transfer the disease from one fly to another,—we know. But here our knowledge is at fault. We have not learnt why this fly-epidemic is more rife in some seasons than others. We are ignorant concerning the methods of multiplying this fungus at will, and of launching it against our enemies. We cannot tell whether it is capable of destroying *Stomoxys calcitrans*, the blowflies, gadflies, gnats, mosquitoes, &c. Experiment on these points is rendered difficult by the circumstance that the fungus is rarely procurable except in autumn, when some of the species we most need to destroy are not to be found. Another question is whether the fungus, if largely multiplied and widely spread, might not prove fatal to other than Dipterous insects, especially to the Hymenoptera, so many of which, in their character of plant-fertilisers, are highly useful, or rather essential to man.

Another fungus, the so-called "green muscardine" (*Isaria destructor*), has been found so deadly to insects that Prof.

Metschnikoff, who is experimenting upon it, hopes to extirpate the *Phylloxera*, the Colorado beetle, &c., by its agency.

Coming to better-known and still under-valued fly-destroyers, we have interfered most unwisely with the balance of Nature. The substitution of wire and railings for live fences in so many fields has greatly lessened the cover both for insectivorous birds and for spiders. The war waged against the latter in our houses is plainly carried too far. Whatever may be the case at the Cape, in Australia, or even in Southern Europe, no British species is venomous enough to cause danger to human beings. Though cobwebs are not ornamental, save to the eye of the naturalist, there are parts of our houses where they might be judiciously tolerated : their scarcity in large towns, even where their prey abounds, is somewhat remarkable.

But perhaps the most effectual phase of man's war against the flies will be negative rather than positive, turning not so much on putting to death the mature individuals as in destroying the matter in which the larvæ are nourished. Or if, from other considerations, we cannot destroy all organic refuse, we may and should render it unfit for the multiplication of these vermin. We have, indeed, in most of our large towns and in their suburbs, abolished cesspools, which are admirable breeding-places for many kinds of Diptera, and which sometimes presented one wriggling mass of larvæ. We have drained many marshes, ditches, and unclean pools, rich in decomposing vegetable matter, and have thus notably checked the propagation of gnats and midges. I know an instance of a country mansion, situate in one of the best wooded parts of the home-counties, which twenty years ago was almost uninhabitable, owing to the swarms of gnats which penetrated into every room. But the present proprietor, being the reverse of pachydermatous, has substituted covered drains for stagnant ditches, filled up a number of slimy ponds as neither useful nor ornamental, and now in most seasons the gnats no longer occasion any annoyance.

But if we have to some extent done away with cesspools and ditches, and have reaped very distinct benefit by so doing, there is still a grievous amount of organic matter allowed to putrefy in the very heart of our cities. The dust-bins—a necessary accompaniment of the water-carriage system of disposing of sewage—are theoretically supposed to be receptacles mainly for inorganic refuse, such as coal-ashes, broken crockery, and at worst the sweepings from the floors. In sober fact they are largely mixed with the rinds, shells, &c., of fruits and vegetables, the bones and heads of

fish, egg-shells, the sweepings out of dog-kennels and hen-houses, forming thus, in short, a mixture of evil odour, and well adapted for the breeding-place of not a few Diptera. The uses to which this "dust" is put when ultimately fetched away are surprising: without being freed from its organic refuse it is used to fill up hollows in building-ground, and even for the repair of roads. A few weeks ago I passed along a road which was being treated according to the iniquity of Macadam. Over the broken stones had been shot, to consolidate them, a complex of ashes, cabbage-leaves, egg- and periwinkle-shells, straw, potato-parings, a dead kitten (over which a few carrion-flies were hovering), and other promiscuous nuisances. The road in question, be it remarked, is highly "respectable," if not actually fashionable. The houses facing upon it are severely rated, and are inhabited chiefly by "carriage people." What, then, may not be expected in lower districts?

Much attention has lately been drawn to the fish-trade of London. It has *not*, however, come out in evidence that the fish-retailers, if they find a quantity of their perishable wares entering into decomposition, send out late in the evening a messenger who, watching his opportunity, throws his burden down in some plot of building land, or over a fence. When I say that I have seen in one place, close alongside a public thoroughfare, a heap of about fifty herrings, in most active putrefaction and buzzing with flies, and some days afterwards, in another place, some twenty soles, it will be understood that such nuisances can only be occasioned by dealers. To get rid of, or at least greatly diminish, carrion-flies, house-flies, and the whole class of winged travellers in disease, it will be, before all things, essential to abolish such loathsome mal-practices. The dust-bins must cease being made the receptacle for putrescent and putrescible matter, the destruction of which by fire should be insisted upon.

The banishment of slaughter-houses to some truly rural situation, where the blood and offal could be at once utilised, would be another step towards depriving flies of their pabulum in the larva state. An equally important movement would be the substitution of steam or electricity for horse-power in propelling tram-cars and other passenger carriages, with a view to minimise the number of horses kept within greater London. Every large stable is a focus of flies.

VI. THE TRANSFER OF SENSATION.

THE recent discoveries based on the conversion of electric currents into sound-vibrations have suggested the possibility of greater and wider results in the future. Is it not possible to convert light into electricity, and by this means to see objects and witness events not merely at great distances, but in spite of intervening objects. Is it not conceivable that the phenomena which depend on the absorption and reflection of light may be so translated as to become manifest to the sense of touch, thus robbing blindness of more than half its terrors?

Certain phenomena observed and recorded by Dr. J. G. Davey, of Bristol, and recorded in the "Journal of Psychological Medicine and Mental Pathology" (vii., Part 1), throw a new light upon this question, as well as upon certain allied subjects. It is now generally understood that the special senses, such as sight, are merely special developments of feeling. We find creatures utterly eyeless; others exist, again, which have very rudimentary and imperfect eyes, so that, though they are demonstrably conscious of the difference between light and darkness, they are unable to perceive objects. So far as we can judge, their outlook on the world is much the same as what we have if a piece of oiled paper or of ground glass were placed before our eyes. Such animals—*e.g.*, the Doridæ—have eyes placed beneath a skin which is not perfectly transparent, and which has no aperture. From the mere vague consciousness of light not clearly distinguishable from feeling, as met with in the lowest animals and possibly in plants, up to the distinct recognition of variously illuminated objects, as we meet with it in insects, birds, and mammals, we find a gradual chain of development. Sight is not a faculty *sui generis*, standing utterly apart, but has its root in that general sense of feeling which is distributed over the whole surface of the body. The same must be said of hearing, smell, and taste. The faculty which in its crudest state merely takes cognizance of solids becomes gradually refined, so as to be definitely affected by the undulations of the inter-molecular ether.

From this point of view we can better understand what has been called the law of "organic compensation." If one organ is weakened or destroyed, its functions are to some extent undertaken by some other organ. That, *e.g.*, blind

men become wonderfully acute in their senses of hearing and feeling has been known for thousands of years. Dr. Davey quotes, from the "Twenty-first Report of the Directors of the Hartford Asylum," the case of a girl, named Julia Brace, who had lost both sight and hearing, and whose sense of smell became wonderfully acute. "She has been frequently known to select her own clothes from a mass of dresses belonging to 140 persons. Her manner is to examine each article by feeling, but to decide upon it by the sense of smell; and in regard to her own things she is never mistaken. She has been frequently known to discriminate, merely by smelling them, the recently-washed stockings of the boys from those of the girls at the asylum." Having such facts before us, we need, be it parenthetically remarked, wonder little that an ant should distinguish strangers of the same species from its own fellow-citizens. Nor need we feel surprised that the ichneumon should become aware of the presence of a larva deeply buried in perfectly opaque matter.

But the case which Dr. Davey has to describe is of a much more remarkable character. It is not the mere increase of the acuteness of one special sense in compensation for the loss of others. The delicate sense of smell possessed by Julia Brace enabled her to distinguish objects by recognising minute shades of odour which for ordinary human beings are non-existent. But it did not undertake the direct functions of the eye or the ear. It did not, *e.g.*, enable her to read. What, however, is to be said when we find a blind and deaf woman examining a picture or a photograph with the fingers of the right hand, and then being able to give a description—often full and detailed—of its colouring and the several objects thereon? What must we think that she is communicating with "by writing with the finger on her face, which is so sensitive that it receives and transmits to the brain the slightest movements of the finger, whether moved up or down, across, or in any direction?"

The first comment made in many quarters will be a lamentation about Spiritualism, jugglery, DOMINANT IDEAS, and the like. On this hand let us first hear Dr. Davey describe his own position:—"I shall treat the subject in hand from a physiological stand-point. Of matters supernatural or forces outside Nature I know nothing. If anyone here expects me to discourse or speculate on the immaterial, the metaphysical, he will be disappointed: for this single and sufficient reason, I believe in nothing of the kind. As a materialist I hold that to degrade matter as is

now done, to regard matter as else than the mainspring,—the only direct and sufficient cause of each one and all of the vital phenomena,—else than the ever-potent force at work in and through both the organic and inorganic worlds: and as such doomed, in virtue of natural law, to realise, ever and anon, that sublime adaptation of means to the end, at once sustaining, perfecting, and all-wise: so I say to degrade matter is to stem the tide of truth, of progess, and humanity. Matter and force stand now, as they ever have done and will continue to stand, in the near relation to each other of cause and effect, and so it is they cannot be separated from each other." Surely after such a confession of faith we need not expect Dr. Davey to err in the direction of the occult and the mystical!

The woman upon whom the observations have been made is a Mrs. Croad, of Clifton; she became totally blind in 1870, deaf in 1871, and is moreover partially paralysed.

In the experiments performed, in the presence of Drs. Davey, Andrews, and Elliott, every precaution seems to have been taken. The blindness of the patient was not taken for granted, but she was thoroughly blindfolded. Although "the eyelids of Mrs. Croad have been for many years persistently closed by a spasmodic action of the muscles," a pad of cotton-wool was placed over each orbit; "the face was then covered by a large and thickly-folded neckerchief: this was tied securely at the back part of the head, and—even more than this—more cotton-wool was pushed up towards the eyes on either side of the nose. Not content, however, the aid of two fingers of a bystander were called into requisition, and with these a continued pressure was kept up outside and over the neckerchief and wool, and above the closed eyes." Moreover the room was on two occasions very thoroughly darkened. Under these circumstances the experiments were conducted, and, as far as can be judged by anyone not actually present, the results must be accepted as decisive proof that the fingers were doing duty for the eyes. On a picture card or a photograph being handed to her, she "places it on or about the chin or mouth, and perhaps draws it across the forehead, but the minute examination of the card is apparently the work of the fingers of the right hand. These several acts are, for the most part, followed by a quiet and intense thought, a well-marked concentration of mind on the picture, when, after a short time, she writes on a slate kept near her a description—sometimes a full and detailed one—of the card, its colouring, and the several objects thereon. Occasionally her rapid and precise perception—

or, if you prefer the word, conception—of the picture, and of the many, though minute and trifling, objects going to form its entirety, is really startling."

We have already mentioned the manner in which Mrs. Croad's friends communicate with her, by writing, so to speak, with the finger on her forehead. This the author does not think very remarkable, all that is requisite being a heightened sensitiveness of the nerves of the face. But her daughter communicates with her in a different manner. Miss Croad does certainly move her fingers over and about the face of her mother, but—unlike visitors and friends—forms few, if any, letters or words. "As a rule it was simply requisite that she put herself in a close or personal contact with her mother, to convey to her what was wished."

Mrs. Croad is also said—indeed Dr. Davey gives an instance from his own experience—to have the power "of detecting, as it were, by sympathy or by a community of ideas and feeling, any letter written by a friend of hers, and put into her hands by a third party." We should be rather disposed to refer this power, if it really exists, to an intensification of the sense of smell, as in the case of Julia Brace.

There are other features of the case for which Dr. Davey does not personally vouch, but which are much more inexplicable. Thus:—"It is said by those near and dear to her that such is Mrs. Croad's prevision that she has been known to have foretold my own visits to her: what I mean is, that on my approach to the house she occupies, but when still at a distance from it, and unseen by anyone about her,—in fact not within sight,—she has said 'Dr. Davey is coming; he will be here directly.'" This is, indeed, very difficult to believe, and we shall take the liberty of referring it to that great group of occurrences, real or supposed, on which we suspend judgment. The author mentions, however, that his friend Dr. Maclean had, in the earlier part of his practice, a hysterical patient who displayed "the same lucidity." "But this is clairvoyance," will be the exclamation of many, "and, if clairvoyance, delusion!" What it is to be called seems, however, to us a very subordinate question. The first consideration is, Are the details above given, of the perception of pictures and photographs with the fingers, actual facts? We must avow that we see no reason to doubt it. The woman is pronounced blind, not merely on current report, but on substantial medical authority. The precautions taken, in case she still possessed any remnant of sight, seem fully sufficient, especially if we call to mind that on two

occasions the room was darkened. The only loophole left for those who contend that Mrs. Croad and her friends are deceivers, and have succeeded in mystifying Dr. Davey and his professional friends, is the theory of collusion. Did any person present, for instance, and more especially the daughter, convey to Mrs. Croad hints as to the nature of the pictures and photographs by means of touches or pressure? It has been already stated that a peculiar "sympathy," or "community of ideas and sensations," existed between the mother and the daughter. This point has not escaped the attention of the author. He informs us that "Miss Croad stood or sat, as a very general rule, on the left of her mother and very close to her; in fact the head of Mrs. Croad reclined on the right shoulder of her daughter, to say nothing of the frequent, though temporary, contact of the fingers of Miss Croad with the cheek of her mother." Dr. Davey, therefore, very naturally asks, "In what relationship, if any, did such close and personal contact of these two persons stand to the strange perceptive power already explained with regard to the picture-cards and photographs? Was the said contact the cause or source in any degree of the lucidity or clairvoyance manifested over and over again by Mrs. Croad, and witnessed by so many?" It has been suggested that Miss Croad did, in some strange way, convey to her mother during the testing a knowledge of the cards, the objects represented on them, their colours, &c. Well, the suggestion was acted on: the same testing, on being again and again repeated, and in the absence of Miss Croad from the room occupied by her mother, proved altogether and conclusively in favour of Mrs. Croad. The same evidence of the same "transference of special sense" from the eyes to the fingers was always forthcoming.

Hence, therefore, except we are prepared to say boldly "*Tant pis pour les faits*," we must accept the phenomena as genuine, and may, if we please, pronounce them clairvoyance.

But we must now refer to the two cases where the experiments were performed, as it would appear successfully, in a darkened room. Here the eyes would evidently be at fault. Sight depends plainly on a perception of the rays of light partially absorbed by and partially reflected from the surfaces of bodies illuminated. But where there is no light, either absorbed or reflected, seeing, as we commonly understand it, can be performed neither by the eye nor by any other organ of the body acting vicariously in its stead. Two suppositions are, however, still open:—Do objects which

have been illuminated, and which in consequence of their varied colouration have been differently affected in different parts, retain for a longer or shorter time the power of acting upon a highly—we will say a morbid—sight organ? Is phosphorescence possibly a general property of matter, provided we had a sufficiently delicate test for its recognition?

Our second suggestion is, Do the phenomena above detailed prove the transference of the sense of sight from the eye to the finger-tips, or rather the development in them of a new sense not dependent on light in the ordinary sense of the term? The well-known experiment of Spallanzani on bats, which Dr. Davey quotes, as well as certain phenomena of insect life with which we have been much concerned, seem to favour this notion. The possibility of senses other than the five commonly recognised in man and the vertebrates generally cannot be rationally denied. Positive instances of their occurrence are still to seek.

Whether either of these suppositions will explain all the phenomena here noted is, however, very doubtful.

The author says, "It should be stated that at my second interview with Mrs. Croad, and in the presence of Dr. Andrews and others, certain of my own personal and private convictions on a particular subject became, as it would seem, in a strange and exceptional manner, known to Mrs. Croad. She asked me if I would allow her to tell me a secret in my own life-history, and would I be offended if she wrote it on her slate? I replied 'No.' That written on the slate was and is a fact, than which nothing could or can be more truthful and to the point. Dr. Andrews is prepared to verify this." Here all explanation in the present state of our knowledge, is wanting. We fail to see how any known—it might almost be added any conceivable—sense could enable one person to perceive the past experience of another. Many readers will at once cut the knot by a simple denial. For our part we do not feel at liberty to escape from the difficulty in this manner. We are accustomed to accept the evidence of a gentleman and scientist unless we have already found him to be a defective observer and self-deceiver, or unless his statements are mutually contradictory or opposed not to imperfect and doubtful theories, but to established facts.

We read further:—"It should be added, on the authority of Mr. Westlake, that Mrs. Croad asked his wife whether there was a room beyond (pointing where there was a passage). Being told 'Yes, two,' she said 'What does the

servant do down there at night when you are all in bed?' She was told that the servant had no business there, and the reply was 'Well, she does go down there; I have known her do it more than once. She takes off her boots first.' It is added, 'We made inquiries, and found that when she thought we were all asleep the girl went into these rooms and helped herself,'"—little thinking that her movements would be traced by a blind and deaf woman!

It is to be deeply regretted that such statements as we find in Dr. Davey's pamphlet, instead of being carefully verified and then rationally studied, as would be the case if some novel phenomenon in inorganic nature were concerned, are contemptuously denied by some, and purposely interwoven with charlatanism by others.

ANALYSES OF BOOKS.

Butterflies, their Structure, Changes, and Life-Histories, with Special Reference to American Forms. Being an Application of the "Doctrine of Descent" to the Study of Butterflies. With an Appendix of Practical Instructions. By Samuel H. Scudder. New York: Henry Holt and Co.

This fascinating volume opens with a curious fact. "A box of butterflies hanging on the wall of a fellow-student's room in college first introduced the author to the enjoyments of a naturalist's life." Mr. Scudder begins his task with an account of the structure of the eggs of butterflies, and of the internal changes which take place during the development of the larva, as far as is yet known. On this subject much work is still required. The question further suggests itself, To what extent do the forms and the tracery of these eggs—many of which are here beautifully figured—exhibit relations in closely-allied species and characteristic differences in distinct groups? Are the peculiarities of the egg in any way adapted to the circumstances in which it is placed?

Coming to the caterpillar, we find a careful and well-illustrated account of its general structure. In figure 21, representing the head of the caterpillar of *Danais Plexippus*, we note an oversight in the lettering: *a* evidently is a side, and *b* the front view of the head. The author points out in caterpillars two foreshadowings of the future state of the insect, or, to speak more precisely, two structural peculiarities which have no immediate purpose. Thus the spiracles are absent from certain of the median segments of the body. The only reason we can see for this arrangement is, that in the perfect insect spiracles in this region would interfere with the support of the wings and the apparatus for their movement. Even in the disposition of the spines along the back we have a pre-indication of the future separation of the thorax and abdomen.

Not all entomologists are aware that the vesicles of the seventh segment of the caterpillars of many of the "blues" secrete a fluid very grateful to ants, which, in consequence, instead of devouring the caterpillar, carefully defend it from the attacks of ichneumons.

The author calls special attention to a question which, if old, is by no means thoroughly settled: Why do butterflies deposit their eggs upon the kind of plant suitable for the nourishment of the young? He writes—"Let us take, for instance, the viceroy

(*Basilarchia Archippus*), which during the butterfly life has never tasted, can by no possibility ever taste, of willow or poplar; that it should choose just those trees necessary for the food of progeny it is never to see defies our powers of explanation on any hypothesis which leaves all to blind forces." Though by no means pledged to any such hypothesis, we think the difficulties of the case scarcely so great as the learned author represents. Granting that the mature butterfly has never tasted willow or poplar leaves, why should we assume that it has forgotten the diet of its earlier stages from which all its tissues have been elaborated? Is it not quite conceivable that, by the smell of such trees, the female may be stimulated to oviposition? If we pronounce this and similar phenomena to be the results of a Divinely implanted "instinct," we have to face the difficulty that such instincts mislead, as in the case of the blowfly, who deposits her eggs not upon carrion, but upon flowers with a carrion-like odour, where the larvæ of course perish.

Referring to the fact that the young caterpillar, immediately after emerging from the egg, devours the shell, the author pronounces this act "plainly a provision of Nature, by which the tender animal is rid of a sure token to his enemies of his immediate proximity. Is this reason or instinct? and, if instinct, will those who believe this power to be only an accumulated inheritance of ancestral wisdom pray give us a single suggestion of the line of descent by which this lonely, defenceless creature learned his art?" We are reluctant to differ from a naturalist of Mr. Scudder's eminent merit, but to us the whole transaction appears in another light. We do not see that the egg-shell is devoured as a precaution against enemies. Suppose an insectivorous bird finds the empty shell of a butterfly's egg upon a leaf. How is he to know whether the inmate escaped to-day or yesterday, whither it has wandered, whether or no it has already fallen a victim to some other bird, or whether the larva has emerged in due course, or the shell has been broken and its contents devoured by some predatory insect? We suspect that this habit of the young caterpillar is an instance of that preference for animal food which most creatures show in the earliest stages of their existence.

Hurrying over a great extent of important matter, we come to a chapter on the "Origin and Development of Ornamentation." It is very justly remarked that in the butterflies—and probably in them alone—there is a direct relation between beauty and rank, the most variegated and exquisite patterns being found in the higher families. This, the author adds, is what should be expected on the theory that the lower represent earlier, and the higher forms later, developed from the common stock. He points out the wide difference between the ornamentation of vertebrate animals and that of butterflies. The former is the result of a series of protracted changes, extending over months of the animal's life. In butterflies the wing-scales are found at once

during the pupa state, and when the insect is as far withdrawn as possible from external influences. Still he thinks that in the two groups the phenomena do not originate in distinct proximate causes, and that among vertebrates, as among insects, "we shall be forced to discard the idea of direct physical causation." This is substantially an admission that the laws of the production and distribution of colour in animals are beyond the reach of man's intelligence.

He points out several objections to the theory of the Rev. H. Higgins, who maintains that the dark spots are chiefly seated on the wings in consequence of the greater facilities there for the deposition of colouring-matter. Mr. Scudder shows that, on the contrary, in the body of the wing the coloured spots are invariably placed in the interspaces between the longitudinal veins.

The author's own hypothesis is that "the wings of butterflies first showed signs of divergence from uniformity by a deepening of the colour next the outer margin, which thereafter became separated into distinct transverse bands: these bands in breaking up gave rise to dark-veined or to spotted wings, which served as the basis for all the variegated patterns of the present day, including ocelli, which are only specialised forms of simple interspacial spots."

It has always seemed to us that the intensification of colour along the margins of the wings, or of certain portions of the wings, is connected with capillary attraction. With the author's observation that "to a certain extent there is a polar distribution of markings" we fully agree. Mr. Scudder does not appear to lay much emphasis upon "sexual selection" as a cause of the varied tints and patterns in butterflies. Nor is he an unlimited believer in the doctrine of protective colouration. He asks, "Can such a play of plan in ornamentation be explained as purely for the purposes of the ephemeral creature itself? If it cannot,—if, for instance, it is of no advantage to the butterfly that its second brilliant ocellus should occur in the area of the first rather than of the second vein,—then it cannot have arisen through natural selection without the guidance of a higher law, which has other ends for beauty than the mere survival of the creature possessing it."

In the chapter on "Ancestry and Classification" we find the following significant passage:—"That the groupings and relations of structure among animals are clear to the human mind,—that they present an orderly arrangement and a harmonious inter-combination which appeals to his reason,—is sufficient proof that natural selection, in all its wondrous and pervading power, acts under law, a law of Evolution which is no slave to the forces of Nature, but brings them into subservience to its ends; a law which is working out the plans of a Supreme Intelligence by ways which man may apprehend, but has not yet comprehended."

We regret that we must here bring our survey of this work to

an abrupt end. An entire number of the "Journal of Science" would not suffice for the worthy exposition and discussion of its views. We can only hope that the specimens we have given will lead our readers to study it for themselves.

Annual Report of the Board of Regents of the Smithsonian Institution for the Year 1879. Washington: Government Printing-Office.

This report presents, as usual, an assortment of matter, some of it of very general and permanent importance, whilst others refer merely to the working details, the financial condition, &c., of the Institution.

A biographical notice of James Smithson, the founder, and of his bequest, conveys the information that he—contrary to the general belief—had not been during his life specially connected with the United States. "He is not known to have had a single correspondent in America, and in none of his papers is found any reference to it or its distinguished men." But we cannot regret that this illustrious Englishman should have selected the American nation for the trustees of his magnificent endowment. Had he bequeathed his fortune to be employed in England, "for the increase and diffusion of knowledge among men," it is easy to guess what would have been its destiny. As it was, some discussion ensued concerning the acceptance of the bequest. Some maintained that Smithson intended to found a university. The "men of words" felt an especial longing to have the control of these funds. F. Wayland, President of Brown University, proposed a university to teach Latin, Greek, Hebrew, Oriental languages, rhetoric, poetry, the law of nations, &c. The proposal to devote the money to the formation of a great national library seemed at one time likely to carry the day. It was even urged that the bequest had better be sent back to England and returned to any heirs of the donor who could be discovered. It was not, in short, until after long and acrimonious discussions—in which one of the representatives asked, "How did it happen that this Government accepted such a boon from a foreigner, an Englishman too?"—that the constitution of the Smithsonian Institution was settled in its present form.

A large part of the present volume is taken up with an illustrated memoir of the Savage weapons displayed at the Philadelphia Exhibition, 1876.

The succeeding papers are on the "Antiquities and National Monuments of Denmark," and on the "French Half-breeds of the North-west." Contrary to what is often asserted concerning mixed races, we are told—"They are not stronger than the

whites, and for a short time perhaps capable of less powerful exertion, but they possess extraordinary powers of endurance, and in the long run would easily outstrip the whites." They are likewise, in opposition to another current nation, decidedly prolific, and have large families.

A number of papers, running to more than a hundred pages, attest the great interest now taken in America in the ethnology, antiquities, and history of the Aborigines,—if so we may call them.

We come next to a memoir on the "Present Fundamental Conceptions of Physics," the substance of two lectures delivered in Vienna by Prof. F. J. Pisko.

Light and Heat. The Manifestations to our Senses of the Two Opposite Forces of Attraction and Repulsion in Nature. By Capt. W. Sedgwick, R.E. London: C. F. Hodgson and Son.

We can do little more at present than briefly indicate the principal points brought forward in this pamphlet. The author considers light, the attractive force, as identical with gravity. He meets the objection that upon this hypothesis gravity would be greater by day than in the night, by arguing that "with daylight comes day-heat, and heat is directly opposed to gravity." He further suggests that if we were provided with a more delicate means of measuring the force of gravity, there would be found a diurnal variation in its intensity. Heat is not identical with light, but its antagonist.

The fundamental phenomenon from which he starts is the spot of light observed on going into a dark room, and applying pressure to the eye ball with the tip of the finger, preferably between the pupil and the nose. This spot consists of a small bright nucleus, surrounded by a number of rings alternately bright and dark, the outermost being very faint, and "the middle ring vividly bright when the pressure is first applied." If pressure is applied to the eye-ball in bright sunlight, the result is merely a dark spot with a faintly luminous border.

A second experiment is as follows:—A piece of well-crumpled silver or tin-foil is laid horizontally in the full sunlight; the eye is then brought to within an inch of it, but in such a manner that the head does not shade off the sun's rays from the foil. The patches of light upon the foil revolve themselves into round spots, all alike in form, size, and general appearance, and each with five bright lines radiating from the centre. A similar spot with five radiating lines is seen if we look at a source of light

through a minute hole pierced in cardboard. Hence he concludes that each such spot represents the effect produced upon the retina of the eye by the incidence of a single separate ray of light. He thinks that the effect produced by pressure on the outside of the eye-ball can only be obtained from within by a pull, and that when a single ray of light passes into the eye it makes itself manifest to our vision by exerting a pull upon the retina of the eye. Hence light is a pulling or attractive force, opposed to heat as a pushing or repulsive force.

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*The Boundaries of Religious Liberty and the Science-Doctrine of Modern Exploration of Nature.** By GUSTAV FRIEDRICH. Leipzig; Siegismund and Volkening.

LET us confess it; we were somewhat led astray by the title of this little book. We expected an examination of the debateable land which lies between the borders of Religion and Science, and perhaps the suggestion of a *modus vivendi* which might put an end to certain unseemly and unedifying disputes. We find a discussion on the light which the modern classification and philosophy of Science has to throw upon the limits of religious freedom. It is obvious that into such questions as the modification or strict execution of the "May laws" we cannot for a moment enter.

But the author's views on the classification and the doctrine of the Sciences admit of being considered in our pages. "The Sciences," he writes, "spring from the experience of daily life. Between that which they teach us concerning the nature of things and that which we experience in common life by our own contemplation there is no specific difference. The Sciences are, so to speak, merely a higher power (*potenz*) of common sense." He establishes three classes—the experimental, the descriptive, and the spiritual (mental or moral) Sciences, concerned with law, politics, art, religion, history, &c. He forgets that as the boundary between experiment and observation is not of a hard-and-fast nature, so the sciences based on these two great methods of research cannot well be treated as decidedly distinct classes. His judgment on those who do not accept this dualism is sufficiently severe. In illustration of his way of thinking we quote from a Note on the Bibliography of Scientific Methodology the following:—"Herbert Spencer's 'Essay on the Classification of

* Die Grenzen der Religions freiheit und die Wissenschaftslehre der heutigen Naturforschung.

the Sciences, from which we might have expected something, is worthless. He does not even recognise the difference between the Natural and the Moral Sciences, without mentioning that of the two subdivisions of the former. He divides the Sciences into concrete, abstract, and abstract-concrete, without imagining that the forms of the knowledge stored up in them are perfectly indifferent for its trustworthiness and value. Still more deplorable is Boens, 'La Science et la Philosophie, ou Nouvelle Classification des Science.' He arranges the Sciences according to the ideas, substance, quality, and relation, and vaunts this as the basis of the clasification of Comte the Positivist. It is curious what is put forward under the garb of Positivism! We naturally find Comte's fundamental error not here, but in his total ignorance of the gulf between the natural and the moral sciences, so that he could consider a *physique sociale* as possible."

This passage is the more remarkable as certain thinkers, entitled to consideration, hold that Comte's chief merit lies in his ignoring the alleged distinction between the "natural" and the "moral" disciplines, and proclaimed the unity of all Science. Our author holds that whilst physical science attains certainties in the shape of laws, the moral sciences cannot rise higher than rules which are defended the more vehemently the more doubtful their formation. The application of these considerations to the question of religious toleration is easy to be seen. That much of what is said bears the mark of great ability cannot be denied. But we could not enter upon its exposition without transgressing the boundaries of our jurisdiction.

Conic Sections treated Geometrically. By S. Holker Haslam, B.A., and Joseph Edwards, B.A. London: Longmans and Co.

The object of the authors is to furnish a concise and uniform method of treating geometrical conics. They define conics as *plane loci*, deducing their general properties from this definition by means of the so-called "auxiliary circle of a point." This construction shows clearly the relation which the three species of conics bear to each other and to the circle. It leads to a method of plane projection, which the authors consider as more powerful than conical projection, and which they name "focal projection."

Roorkee Hydraulic Experiments. By Capt. ALLAN CUNNINGHAM, R.E. Vol. I., Text; Vol. II., Tables; Vol. III., Plates. Roorkee: Thomason College Press.

THE rate at which water is discharged through channels, natural or artificial, is a matter of no small practical importance; yet, strange to say, it has been so little the subject of thorough-going investigation that engineers of well-known ability differ widely from each other if called in to determine the average flow of water passing along a stream or a drain. Instances of such discrepancy have frequently occurred to us when experimenting on the chemical treatment of sewage. Having ascertained the working formula for say 100 gallons, came the question what is the average fair-weather flow from the town concerned; and here the results have varied widely. The flow from one town has been stated to us at every figure from 8 to 14 million gallons daily.

The author finds that experiments on large rivers can seldom be executed with the precision necessary for discovering the general laws of fluid motion. Operations on a very small scale, on the other hand, give results not trustworthy if applied to larger bodies of water. The best opportunity for a fundamental study of the question is afforded by large canals,—such as the irrigation channels of India,—where large volumes of water are in uniform motion in regular channels.

The chief objects of the experiments conducted by Captain Cunningham and his assistants were the discovery of a good method of discharge measurement, an investigation of the applicability of known formulæ for mean velocity, and the discovery of a good approximation to mean velocity.

The chief results reached are that loaded tube-rods give a rapid and sufficiently close approach to mean velocity past a vertical. The author considers that for depths not exceeding 15 feet they should supersede all other instruments. Rods made of tin tubing were found preferable to all others; they require to be as thin as is consistent with rigidity, with a smooth surface. The centre of gravity should be as low as possible in the water, and the convex surface smooth throughout.

Capt. Cunningham finds that discharge-measurements, when carefully executed on his system, do not vary respectively more than 3 per cent. This conclusion is based upon a careful comparison of repeated measurements, and must be pronounced satisfactory.

As regards the existing formulæ for mean velocity, none of them seems generally applicable. That of Kutter, which is the most general, gives an approximation much below the results of direct measurement. This conclusion the author admits as disappointing, especially as he is not able to propose a preferable

formula. The best means of rapid approximation to mean sectional velocity he considers to be the measurement of central mean velocity. The reduction, however, must be accomplished by means of special experiment at each locality.

Among the minor results must rank the observation that "the motion of water in large open channels is essentially unsteady; even in long, straight, and fairly uniform reaches the velocity at any given point is extremely variable from instant to instant, and the stream lines interlace freely in all directions." The maximum velocity past any vertical is, as a rule, below the surface. To measure mean velocity past a vertical the immersed length of such rods must be decidedly less than the depth of the water.

That this work is a valuable contribution to hydraulic science, and that it will repay engineers for a careful study, is our decided opinion.

The Phenomena of the Electric Discharge with 14,400 *Chloride of Silver Cells.* A Discourse by Dr. W. De la Rue, F.R.S., delivered before the Royal Institution.

The battery used in the author's experiments, but a solid electrolyte, silver chloride, is substituted for the sulphate of copper solution. It is impossible to give an abstract of the subject matter without the very numerous illustrations contained in the pamphlet.

Solutions of the Questions in Magnetism and Electricity set at the Preliminary Scientific First B.Sc. Examinations of the University of London from 1860 *to* 1879. Together with Definitions, Dimensions of Units, Miscellaneous Examples, &c. By F. W. Levander, F.R.A.S. London: H. K. Lewis.

Whatever the excellence of this work in other respects, we cannot do other than characterise it as the outcome of a radically vicious system,—that, namely, which makes it the student's great task not to acquire a thorough mastery of his subject with a view to becoming himself a successful interrogator of Nature, but to prepare for passing examinations. We cannot blame Mr. Levander, connected as he is with University College, and consequently with so purely an examinational body as the University of London, for adapting himself to existing circumstances; but

we deeply regret the system which compels men of learning and ability to turn their attention in this direction.

A list of the questions which have been put to candidates at examinations for the last twenty years will of course give the student a very fair notion of the ordeal awaiting himself. We have met with "superior" men who, whilst believing in and defending examinationism, denounce books such as the one before us as "instructions how to cheat the examiner." We cannot accept such a view. If the said "superior" men really wish for realities in place of shams, let them give degrees of B.Sc., D.Sc., &c., to those who have proved themselves capable of research, and to none others. In the meantime everything that tends to make the farcical character of examinationism more manifest has our best wishes.

A Dictionary of Chemistry and the Allied Branches of other Sciences. By Henry Watts, B.A , F.R.S., F.C.S. Assisted by Eminent Contributors. Third Supplement. Part II. London: Longmans and Co.

Mr. Watts and his learned coadjutors are ably and laboriously pursuing a task which reminds us of the much-quoted stone of Sisyphus. As fast as they approach completion new discoveries are brought forward, and require extensions and modifications of what has been already written. The dictionary form which the author has adopted is the only one at all suitable for a science in a state of such rapid growth and transition.

The volume before us completes the record of chemical research as far as the end of 1878, and embodies the more important discoveries which have appeared in 1879 and 1880.

That the editor has executed his difficult task most satisfactorily might have been inferred from the former volumes, even if we had not convinced ourselves by careful examination that such is the case.

Among the more prominent and valuable articles we must call especial attention to that on Heat, which includes the recent important development of what is called thermo-chemistry. The determinations of the heats of chemical combination, of chemical action, of solution as determined by Berthelot, Thomsen, Troost, Hautefeuille, &c., are given at great extent, and the signification of these researches for chemical theory is pointed out. The latest results in thermolysis, or dissociation, are embodied in the same article.

The article on Spectral Analysis is from the pen of Dr. A. Schuster, a physicist who has made this department peculiarly

his own. The latest results of Mr. Norman Lockyer in solar and stellar spectroscopy are stated and discussed. As regards absorption-spectra the author reminds his readers how these are affected by the solvent used, by the degree of concentration, and even by the presence of other bodies, and consequently what great care is needed in employing the spectroscope in analysis.

The article on Light summarises much new and valuable matter, especially as regards circular polarisation. The chemical action of light, especially upon organic matter,—*e.g.*, chlorophyll,—is very far from being fully understood. Thus Pfeffer finds that the decomposition of carbonic acid by plants is most active in the yellow, and descends regularly on either hand from that point. On the other hand, Timinaseff observed the maximum decomposition in the red, corresponding with the characteristic absorption-band of chlorophyll. The blue and violet rays, though absorbed by chlorophyll, are found to have no effect upon the absorptive power of plants.

The article on Volcanic Products is exceedingly interesting. It appears that of the fifteen non-metallic elements twelve, and of the fifty-one metals nineteen, have been found in volcanic products. It is exceedingly probable that others will be detected on careful examination. We can, *e.g.*, scarcely imagine nickel to be generally absent where cobalt is present. Seeing that iodides have been detected, bromides, as the author remarks, will scarcely be absent. The complexity of some volcanic minerals is remarkable. Thus a spongy and crystalline mass from the crater of the island Vulcano contained arsenious and selenium sulphides, boric acid, ammonium chloride, lithium sulphate, and the alums of thallium, cæsium, rubidium, and potassium.

Besides the above-mentioned, and not a few other extensive articles, the work contains notices of numbers of minerals, organic principles, and artificial products, which have either been recently discovered or more thoroughly examined since the appearance of the last Supplement.

We are not aware of any work of reference in any language, covering the whole extent of chemical and chemico-physical science, which can be placed on a level with Mr. Watts's "Dictionary."

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

THE HISTORY OF MUSCLE-READING.

To the Editor of the Journal of Science.

Sir,—Mr. Irving Bishop recently called upon me, while I was in London, and stated that from his childhood he had been accustomed to indulge in one of the modes of muscle- or body-reading; that he had been wont to say so before his European audiences; and that the extract from my letter in your issue in July, to the effect that he had learned what he knew of it from my investigations of "Brown the mind-reader," were inconsistent with the statements he had been making.

In the paper on the "Physiology of Mind-Reading" which you published I stated at the outset that the trick had been known for a long time, and had been performed by different persons in different countries in different ways. It is not improbable, certainly not impossible, that Mr. Bishop may have known of some of these methods before Brown the mind-reader swept across the American continent, carrying everything before him by his brilliant, and up to that time publicly unheard-of, demonstrations. The possibility that Mr. Bishop may have known some one of these methods before Brown's public appearance may therefore be conceded.

The facts, however, are demonstrable that my exposure of Brown the mind-reader directed the attention of Mr. Bishop, as well as all others, to what before was scarcely known at all, even in limited circles; and that after the publication of my researches, which made great excitement in America at the time, Mr. Bishop saw me in regard to them, and did not accept the explanation I had demonstrated. The method of mind-reading by the ear, *without contact*, subject and operator walking near together, the operator judging by the step of the subject, which Mr. Bishop now performs, was fully described in the supplementary letter of my article, which has not been published this side the Atlantic. This interesting phase of mind-reading was developed originally

by a scientific man in America, entirely independently of my own researches.

Mr. Bishop is a professional sleight-of-hand performer, and is not bound to reveal whence he gained all his secrets, and my reference to him was incidental only. He has given the psychologists of England opportunity to investigate the phenomena of muscle-reading fairly and fully, as I understand, and for this he is to be credited and Science to be congratulated, for the phenomena are most remarkable indeed. I am glad to have my own researches confirmed here, as they had long ago been many times confirmed in the States; and it is very interesting to note that Mr. Geo. J. Romanes, William Croom Robertson, and others who have studied the subject in England, have, so far as they have gone, passed step by step through the same stages of doubt and difficulty, and demonstration, that I passed through with my experiments. It is to be regretted that other psychologists whose attention was called to this matter did not also improve this most excellent opportunity to study the action of mind on body. Ten years ago there was not a physiologist or psychologist in the world who would have admitted the possibility of these phenomena; now there is no one who has seen and studied them who will deny their genuineness.

The chief criticism I have to make is on the conduct of Dr. W. B. Carpenter, and in this criticism all who know the facts must be in accord. When Mr. Bishop first came to Dr. Carpenter, the latter surely could not have forgotten that my original paper, "Muscle-Reading *versus* Mind-Reading," had not only been long in his possession, but quotations from it had been made by him in his own writing. He could not have forgotten that a year or more before he had written me in regard to that subject, and that very paper saying that he was so much pleased with that paper, as well as with another monograph of mine in which I had formulated the six sources of error in experimenting with human beings, that he had desired me to send him, as speedily as possible, all my papers on Trance, the Involuntary Life, and allied themes, in order to assist him in the paper he was preparing for publication. He could not have forgotten that in that same letter he stated that these subjects had occupied his mind for forty years, but that I had been able to give them more exclusive and successful attention than had been possible for himself. He could not have forgotten that he also spoke of Mr. Bishop, and some of the phenomena produced by him that he and Prof. Huxley had witnessed. The reprints and monographs that he desired, including the Physiology of mind-reading,—which you published, were promptly sent to him with an accompanying letter.

The next heard of the subject in England is a letter from Dr. Carpenter introducing Mr. Bishop to the scientific world as possessing some novel powers, and giving an implied—though

not absolutely stated—indorsement of Mr. Bishop as a mind-reader, or at least leaving the question an open one. It is certain that the majority, if not all, of those who received a copy of the letter were led to believe that the claim of mind-reading was to be established, and there was great disappointment on finding Dr. Carpenter's letter had given an erroneous impression; and from this disappointment there resulted an indifference to the solid and important basis of fact that existed in those experiments.

The true course for Dr. Carpenter was very simple. He should have stated in clear language that Mr. Bishop was not a mind-reader, as he claimed, but a body- or muscle-reader, but that his muscle- or body-reading, though not new to Science, since it had been exhaustibly studied years before by Dr. Beard, with whom he had communicated on the subject, was yet of the highest interest to students of this side of psychology.

For myself personally there is no cause for complaint, since the priority in absolutely demonstrating the philosophy of muscle- and body-reading has been conceded to me without dispute in America and in Europe; but I fear lest scientific men whose taste would lead them to studies of this kind have been so far repelled by this one false claim that they may be tempted to neglect not only this special phenomenon of muscle-reading, but all the other phenomena of trance and the involuntary life with which are interwoven the profoundest problems of the century.

To my own mind the subject is more interesting after it is explained than before. In the accounts of the early English experiments that crossed the Atlantic the name of Prof. Huxley was used as a quasi-endorser of Mr. Bishop; but a letter from Prof. Huxley, that reached me before I left New York, made it quite clear that his name had been used without authority.—I am, &c.,

GEO. M. BEARD.

London, August 17, 1881.

PS.—The term "muscle-reading," coined by me on the first publication of my experiments, may perhaps be replaced by body-reading, since the phenomena are produced not by any one muscle or by any limited groups of muscles, but by the body or a part of the body acting as a whole. A certain fineness and mobility of organisation is essential to the highest success in these experiments; but in a degree we are all muscle-readers, and the number of good performers in America is very large. Brown the mind-reader was especially remarkable for the rapidity and precision of his performances, although, like all of his class, he met with very many failures, and with some persons failed utterly.

"JUMPERS" IN SOUTH AFRICA.

To the Editor of the Journal of Science.

Sir,—I was much pleased with the articles in the "Journal of Science," by Dr. G. M. Beard, on the "Jumpers" of Maine. The same phenomena were observed here amongst a set of farmers living about the Divisions of Richmond and Graaf Reinet, in this colony.

The first one I met with was a young man of about twenty years; he was then (about the year 1837) on a visit to Stellenbosch, when all the different tricks mentioned by Dr. Beard were played upon him. His rapid repetition of short sentences, when startled, was most remarkable and quite uncontrollable by his will. In more than one instance he would utter a whole sentence even before the last part had been expressed (?), which often annoyed him very particularly when he found that he had made use of words which were not fit to be expressed in company of ladies. He knew what was coming, but could not help himself. This young man was a Liebenberg, and the disease was principally noticed in that family.

A couple of years after that I again came across an old man, a Mr. Charles Liebenberg, who was subject to the same disease, as also three of his sons-in-law, named Pienaar.

Not many years ago, whilst living at Worcester (South Africa), I became acquainted with another person of the same stamp, Mr. Conradie, a resident of Graaf Reinet, who, as far as I am aware, is still alive. He would throw, strike, jump, &c., repeating the word also at the same time, whatever he was ordered to do when startled. I was present one day when some of these tricks were played on him, when he gave a young lady who was standing close to him such a violent blow as to send her spinning to the ground. He answered completely to the description given by Dr. Beard ("Journal of Science," 1881, p. 87).

None of these men were deficient in intellect; the one last named is a decent, well-to-do farmer. Two of the Pienaars were, moveover, brave men. They were all very ticklish, and sometimes it was only necessary to point with the finger at them and mention a word. Both Conradie and the Pienaars are of French descent.—I am, &c.,

J. W. Hugo,
Civil Commissioner and Resident Magistrate,
Clanwilliam, South Africa.

COALESCENCE OF BRANCHES.

To the Editor of the Journal of Science.

Sir,—Permit me to inform you of an instance where two distinct stems of a tree have come together and united into one without the intervention of man. If any one leaves the Chingford Branch of the Great Eastern Railway at Wood Street Station, makes for Chestnut Walk, and takes the first turn leading to Epping Forest, he will find, keeping to the left, the remains of a tall straggling hedge. Two stems of the hawthorn, which rise separately from the ground and remain distinct to the height of about 3 feet, coalesce completely into one.—I am, &c.,

An Epping Forester.

INFANTICIDE AMONG ANIMALS.

To the Editor of the Journal of Science.

Sir,—With reference to the Duke of Argyll's statement that infanticide is a point in which man differs unfavourably from the lower animals, allow me to mention, in addition to the facts given by your correspondents on pp. 367 and 432, that the domestic drake very frequently destroys ducklings by a blow at the back of the neck. I knew an instance of a drake belonging to Mr. W. Clarke, of Whirlow, near Sheffield, which was very much given to this offence, and has been seen in the very act.—I am, &c.,

A New Subscriber.

NOTES.

The "Morality of the Medical Profession" has been made the subject of an objectionable article in the "Modern Review." In reply have appeared a letter from "Two of the Profession"—both, forsooth, anti-vivisectionists—and a protest from one whom the "Medical Press and Circular" pronounces "a scientific *savant*, one holding an unassailable position in the social world, and a highly esteemed gentleman!" We do not agree with the writer as to the policy of ignoring attacks. The tactics of social and political agitators consist mainly in throwing dirt, in the hope that some of it will stick. The persistent abuse levelled at the medical profession is part and parcel of a widespread anti-scientific movement.

Prof. Hutchinson, in his Lectures on the Laws of Heredity ("Medical Press and Circular"), mentions a very interesting fact ascertained in Berlin. Among Catholics, who prohibit consanguineous marriages, the proportion of deaf-mutes is 1 in 3000; among Protestants, who view such marriages as permissible, the ratio is 1 in 2000; whilst among Jews, who encourage intermarriage with blood-relations, the deaf-mutes are as 1 in 400.

Mr. J. T. Humphreys ("American Naturalist") records a case of a king-snake (*Ophibolus Savi*) killing and devouring a full-grown water-mocassin (*Ancistrodon piscivorus*).

Mr. A. E. Bush, of San José (in the same journal), describes the butterfly trees of Monterry (*Pinus insignis*). Three of these trees, each about 18 inches in diameter, were completely covered with live butterflies.

On June 2nd, according to the same journal, thousands of white butterflies (*Pieris monusta*) passed from west to east over certain districts of South Carolina.

Arthur de Noé Walker, M.D., one of the few medical men who deem it consistent with their duty to Science to identify themselves with the anti-vivisection hubbub, has sent round a circular denouncing the "Lancet" for its recent strictures on Homœopathy.

Prof. B. Pierce maintains that the discovery of Neptune was "only a happy accident;" the planet found by Galli, in accordance with Leverrier's directions, was *not* the planet "to which geometrical analysis had directed the telescope."—*Science.*

Trichinosis is still exciting much attention in both continents. However, the alarm is not sufficient to lead a certain part of the public to abandon the practice of eating raw and semi-raw meat.

With reference to Dr. Clevenger's note on the close connection of the primitive desires ("Science," January 15, 1881) we learn that "mulieres in coitu nonnunquam genas cervicemque maris mordent."

Prof. Cope ("American Naturalist") points out that the mammalian types with reduced digits are dwellers on dry ground, whilst those with more numerous digits inhabit swamp and mud.

Dr. F. L. Oswald, writing on "Physical Education," in the "Popular Science Monthly," makes a powerful onslaught upon asceticism.

Dr. Dyce Duckworth ("Practitioner") enlarges on the "Insufficient Use of Milk." He says "It seems certain that our farmers can no longer grow cereals so as to make them a source of profit." For a conclusive reply to this assertion we may refer him to Mr. Prout's recent pamphlet.

We learn that mosquitoes occur in the Loffoden Islands,—bare, rocky, constantly swept by the wind, and free from marshes and jungles. What can be their alleged sanitary function there?

According to the "Scientific American" a curious observation has been made by Dr. Moritz Benedict, of Vienna. He published a book about a year ago, "Anatomische Studien an Verbrechergehirnen," in which he states that in nearly one-half of the brains of persistent criminals the superior frontal convolution is not continuous, but is divided into four sub-convolutions, analogous to the disposition of the parts found in predatory animals. In a recent paper ("Centralblatt für Med. Wiss.," November 13, 1880) he argues that much of moral perversity may and must be the result of this deflection of the cerebral organs from the normal type, producing, as it necessarily would, other arrangements of cerebral nutrition and hæmostatic relations. It cannot be fortuitous that the mental characteristics of the most perverse criminals, and also the cerebral anatomy, both resemble those of wild beasts: this double analogy must be one of cause and effect.

[If the persistent, hereditary criminal is thus marked out by a peculiar central conformation, the prospects of his reclamation must surely be very slender.]

The "Königsberger Land-u. forst. Zeitung." reports that cases of hermaphrodism are frequent in fish, especially in the sturgeon.

Principal J. W. Dawson, in a Lecture on the "Relations of Natural Science to Monistic and Agnostic Speculations," reported in the "Philadelphia Times," discussed the three theories

of Herbert Spencer as to the origin of things self-existing, or self-created, or created by external agency, and raised a laugh by saying that the possibility of creation of an agency within had never occurred to Mr. Spencer.

Dr. Dolan, writing in the "Medical Press and Circular," proposes some much-needed restrictions on dogs and dog-fanciers.

Dr. W. B. Carpenter, in his pamphlet on Vaccination, delivers himself into the hands of his opponents. He asks, "Do we abstain from drinking water because it is sometimes poisoned by lead?" forgetting that the presence of lead in water can be readily detected.

It is said that Prof. Huxley is a candidate for the Linacre Chair of Physiology at Oxford, vacant by the death of Prof. Rolleston.

According to a paper read before the Geographical Society of France, the Hoang-Ham—a strychnaceous plant, found in Tonquin—has been used with success as a remedy for the bite of the cobra.

The ink of the Cephalopoda when purified contains, according to M. P. Girod ("Comptes Rendus"):—

Carbon	53·60
Hydrogen	4·04
Nitrogen	8·80
Oxygen	33·56
	100·00

M. A. Brongniart has laid before the Academy of Sciences an account of the egg-cases of the *Mantis*, of the hatching, and the first moulting of the larvæ. His observations have been made in Algeria.

It is rumoured that Prof. Riley is likely to be reinstated as Entomologist to the American Department of Agriculture.

The "North American Review" has a paper by Prof. E. S. Morse, on "Prehistoric Man in America." It is an admirable summary of the present state of knowledge as regards the early history of our race.

Prof. Marsh, in an "Address on the History and Methods of Palæontological Discovery," remarks, very justly, that if Cuvier had "had before him the disconnected fragments of an Eocene tillodont, he would have referred the molars to one of his pachyderms, the incisors to a rodent, and the claw-bone to a carnivore.

"Harper's Monthly," in reviewing "Mivart on the Cat," declares that a belief in Evolution, far from leading to a denial of "Creation," distinctly affirms it, and that a candid study of

organic life makes evident the logical need for the Theistic conception.

M. Pasternatzks has investigated the seat of cortical epilepsy and of hallucinations. He finds that the attack of epilepsy induced in the dog by the essence of absinthe depends on certain parts of the grey matter of the cerebral hemispheres, and is consequently true cortical epilepsy. The hallucinations observed in the author's experiments are probably due to the exciting action of absinthe on the subcortical sensitive centres.—*Comptes Rendus.*

According to M. Arsonval (" Comptes Rendus ") eggs during the first days of incubation absorb much heat. This process is accompanied by an absorption of oxygen and an abundant liberation of carbonic acid. During sleep animals absorb much oxygen and evolve little heat, the emission of carbonic acid varying little. Animals are not merely the seat of oxidations and combustions. Every living being is at the same time a reducing apparatus which effects syntheses.

We learn that a medical branch of the " Malthusian League " has been formed in this country.

Sir James Paget, in his Presidential Address at the Medical Congress, said—" It would be difficult to think of anything that seemed less likely to acquire practical utility than those researches of the few naturalists who, from Leeuwenhoeck to Ehrenberg, studied the most minute of living things, the Vibrionidæ. Men boasting themselves as practical might ask, 'What good can come of it?' Time and scientific industry have answered, 'This good: those researches have given a more true form to one of the most important practical doctrines of organic chemistry; they have introduced a great beneficial change in the most practical part of surgery; they are leading to one as great in the practice of medicine; they concern the highest interests of agriculture, and their power is not yet exhausted.' "

The following specimen of Science for the million is taken *verbatim et literatim* from the " Family Herald " of August:— " Mr. Wallace says that the butterfly is unknown in South America, the West Indies—except as a rare straggler in Cuba—and the Pacific Islands."

We learn that some 130 of the members of the Medical Congress were adroitly taken to the Croydon Sewage Farm, and regaled at a lunch the ingredients of which—as they were duly informed hy Dr. A. Carpenter—were " transformed sewage." Who guarantees the completeness of the " transformation ? "

According to the " Siècle Medicale " a man desirous of killing himself hammered a dagger, 10 centimetres in length, into his head up to the hilt. No unusual sensations being produced, a

doctor was sent for, in whose presence the blade was extracted by mechanical force. No pain was still experienced, but lest unforeseen complications should set in he was sent to a hospital, where he remained in perfect health for a week, and was then sent home.

The following are examination questions which are said to have been proposed by a "Congress of Domestic Economists":—

"Do you remember why all animals who have a long skull are called vertebrate animals?

"What are germs, and how can you kill them?

"Every kind of food that grows in the ground is called a vegetable. Is flour a vegetable?

"Why do men and boys that work hard require a good deal of food that makes fat, called 'body warmers'?

"Why is an egg that has been beaten or whipped a cooked egg?"

The greatest rainfall in twenty-four hours in the British Islands has been registered in the Isle of Skye.

According to Mrs. Mary Treat ("American Naturalist") the great crested flycatcher (*Myiarchus crinitus*), when building its nest in a box, fixed in a vineyard for the purpose, at first holds the sticks by the middle, and tries in vain to force them through the door. At last the bird learns to push in the sticks end first, and the nest is soon completed. Is not this a case of reasoning, a right conclusion being drawn from facts observed, and being then practically applied?

According to the "Tucson Citizen" a large and remarkable cavern, more than a mile in extent, has been discovered in the Santa Rita mountains, in Arizona.

The "American Naturalist writes—" No one is more solicitous for the protection of our wild animals than the true sportsman." This may be the case in America. In England he is utterly regardless of every creature not in the game-list.

M. V. Galtier submits to the Academy of Sciences the following startling conclusions:—The injection of the virus of rabies into the veins of sheep does not bring on the disease, but seems, on the contrary, to confer immunity. Rabies may be transmitted by inoculation, and by the introduction of the virus under any circumstances into the digestive passages of any animal. He even thinks that the injection of the virus into a vein may prevent the outbreak of hydrophobia *after* a bite from a rabid animal!

A writer in the "Boston Journal of Chemistry" seems to regret that a physician "is not required to write, talk, or in fact do any act which is fairly open to the world." We submit that

if there is one point in which the charlatan is invariably superior to the man of sterling ability, it is in the art of talking.

Dr. Lenz contends, from the presence of fresh-water fossils, that the Sahara is not the bottom of a sea which has been elevated.

In order to account for the mysterious disappearances of persons, now so common, a French writer suggests the existence of a disease not yet recognised, which, without any previous warning, suddenly resolves the patient into vapour. He even professes to have witnessed the disappearance of a friend with whom he was walking. A very simple consideration overturns this hypothesis. We can scarcely assume that the disease causes the sudden vaporisation of clothing, boots, keys, knives, money, trinkets, and all that the patient had about him at the time of his disappearance. Yet no one has ever found in the streets a complete suit of clothes from which the body of the wearer escaped !

At the recent meeting of the British Medical Association a resolution in favour of vivisection was passed with but one dissentient.

Dr. C. Jehn gives, in the " Chemiker Zeitung," a very striking case of fish perishing by thousands in consequence of water in which flax had been steeped having been allowed to flow into a stream.

M. H. Toussaint ("Comptes Rendus") finds that no contagious malady possesses a greater virulence than tuberculosis, the virus resisting and preserving its efficacy at temperatures which destroy the bacteria of splenic fever. The infection takes place as easily by ingestion as by inoculation.

ERRATUM.

Page 479, line 19 from bottom, *for* "animal" *read* "normal."

NINETEENTH YEAR OF PUBLICATION.

THE

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THE

JOURNAL OF SCIENCE.

OCTOBER, 1881.

I. WEATHER-WISDOM AND THE HARVEST.

DISMISSING as incurable the fanatics who sought a political cause for the series of bad seasons from which we have suffered, we come to a band of meteorologists, professional and amateur, who have latterly been prophesying smooth things concerning the weather and the crops. A wet cycle, we were told, was just coming to an end, and a dry one was beginning, the comparatively favourable harvest-time of 1880 being its forerunner. The present year was to be a repetition of 1868, and when, after a spring dry, but marked by an unusual amount of cold, blighting, northerly winds, a brief wave of high temperature passed over these islands, an excellent harvest was considered as guaranteed. Never was there a more typical illustration of the folly of counting chickens before they are hatched. The critical month, August, has proved exceptionally ungenial,—cold, wet, and boisterous to a degree bordering upon that of "cruel 1879." Thus we see that a dry cycle, if such has actually set in, does not necessarily involve a good harvest. We have had abundance of dry weather when rain would have been more useful, and now the wet has come when drought was needed. We see, further, another illustration of the simple rule that after an exceptionally severe and prolonged winter, such as the past, it is useless to expect a really fine, warm summer.

But before we form the conclusion that the seasons are deteriorating, or that a new "Glacial epoch" is approaching, it will be well to look back to former years. Before us lies a tabular record of the weather, collected by Mr. Glaisher, and taken from the "Farmer's Almanack" for 1880.

These returns extend over the thirty-two years from 1771 to 1803, and present a dismal picture. One summer only is pronounced "fine," and two "moderately fine," but with the drawback of a cold July. We see therefore that the probability of a season cold, wet, or both, during the months of June, July, and August, is something like ten to one. It must not be understood that in the twenty-nine years the whole of the summer was bad. Sometimes a fine June and July favoured the haymakers, and were then succeeded by a wet August and September, to the ruin of the wheat and the barley. Sometimes the case was inverted. But, we repeat, the probability of a preponderance of warm, dry weather from the beginning of hay-time to the end of the wheat-harvest is about as one to ten! The amount of damage varies of course greatly. It may in a moderate season not exceed a couple of millions sterling. In such a year as 1879 it is doubtful if sixty millions would cover the loss. This, we submit, is a matter of the deepest national concern. Should we not be profuse in our gratitude to a statesman who could contrive to reduce the national expenditure by even the smaller of these two sums? We are aware that certain hasty—not to say careless—observers are given to pooh-pooh the agricultural prosperity of the home kingdoms. "If our own harvest fails," say they, "we can import corn from abroad." But as more than half of the national capital is invested in agriculture it is surely of importance to us all if this capital, instead of bringing in a fair return, is diminished by yearly losses. That for the last few seasons this must have been the case appears but too clearly. We have all, therefore, to ask most earnestly whether there is no means of stopping this drain on national resources? One part of the mischief is, speaking in accordance with the present state of human knowledge, irremediable. We cannot secure calm, sunny weather while the wheat is in bloom; we cannot turn on hot weather to secure thorough and early ripening; nor can we banish the storms which lay both hay and corn prostrate. But over the last and most critical point in the career of our crops we have—thanks to a modern invention—an almost perfect power. In fact, to be practically independent of the effects of rainy weather during hay-time and harvest is now entirely within our own option.

For a better understanding of the case we must ask the reader to accompany us to a meadow about the end of June. When the grass has reached full maturity it is cut, and then—if there has been overhead a bright sun in a "glorious midsummer sky," the dew-point well below the temperature,

and a gentle wind blowing—the grass is speedily converted into hay, either by hand-labour, or, as is now often done on large farms, by dint of a hay-making machine. The third day, sometimes even the second, sees the grass thoroughly dried and ready for stacking. Under such favourable circumstances no improvement is needful. But such model weather is the rare exception ; generally there are drawbacks. There may have been a downpour of rain before mowing, so that the grass and the ground are alike soaked ; or the sky may be overcast and the air saturated with moisture, the dew-point being nearly up to temperature. In such cases the grass dries slowly, even in the absence of rain. Day after day it has to be turned over and tossed about, so as to expose fresh surfaces to the air and allow its moisture to escape. But too often rain falls before all this work is at an end. The grass becomes wetted afresh, and the process of drying has to be recommenced almost from the beginning, sometimes twice or thrice. We must endeavour to realise what all this means to the farmer. For hay-making he has generally to hire a number of extra men. Every additional day which passes over before the hay can be safely stacked is of course a direct addition to his outlay. Further, the value of the hay, whether for sale or for home consumption, rapidly declines. Hay, like most vegetable products, contains much matter soluble in water, and on this matter its nutritive value greatly depends. Every drenching, as it lies cut in the fields, dissolves out a portion of its soluble constituents. Decomposition sets in ; its natural fragrance is destroyed, and is succeeded by a musty smell unpalatable to cattle. The final result not unfrequently is that it is not worth getting in at all, or can be used merely for litter. We can thus understand the anxiety of the farmer when he finds that a crop which should have been worth £4 to £5 per load turns out utterly valueless after having cost him perhaps upwards of 20*s*. per acre in attempts to save it. We think he may be excused for that grumbling in which he is commonly supposed to indulge more heartily than the rest of his countrymen.

Bad weather in harvest-time does not, of course, require extra labour for tossing the corn about ; but the sheaves may have to stand for weeks in the fields, the in-gathering being delayed, and the quality and market-price of the grain being seriously affected.

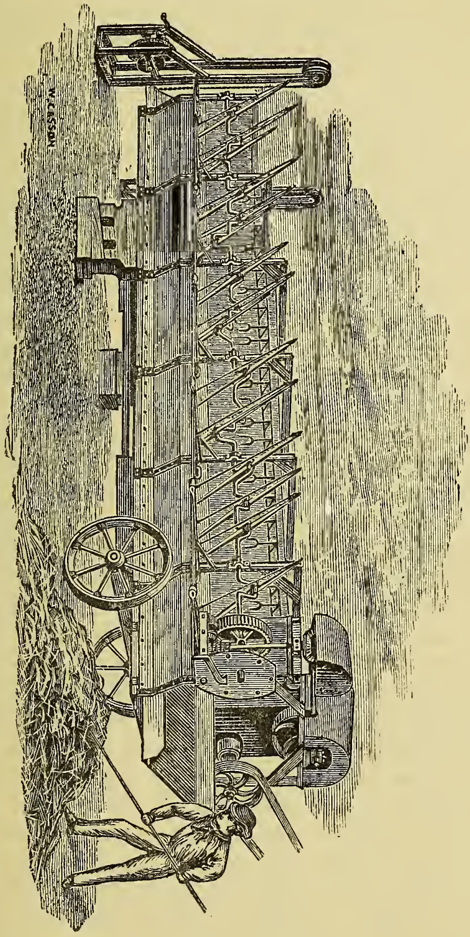
It will surely require no further demonstration that a contrivance which reduces the saving of the hay and corn crops in all seasons to a dead certainty, without the usual

deterioration of quality and increase of expense, must be of truly national importance. Such a contrivance exists, not as a matter of surmise, or probability, but as proved by practical work on a large scale before men not accustomed to wax enthusiastic concerning any novelty placed before them.

It is now twenty-one years since Mr. W. A. Gibbs, of Gillwell Park, Essex, first turned his attention to the subject, and succeeded in devising his drying-machine. Its essential feature is that hot air and the products of the combustion of coke or anthracite, as coming from a portable furnace, are driven by means of a fan right over and through the hay, corn, or other products to be dried. No one will, of course, doubt the superior economy of this direct method of applying heat as compared with kilns and stoves; but it might be supposed, on *à priori* grounds, that the gases of combustion —including, of course, sulphurous acid—would injure the flavour of the hay or other products. This is in practice found not to be the case. The machine-dried hay retains its full natural odour and savour, and is eagerly eaten by the most fastidious cows and horses; animals which are often found much more dainty about the quality of their food than an outsider would suppose. It is curious that the mustiness of an ill-made damp hay is completely removed by this treatment. Of the purifying power of the hot blast we personally witnessed a most surprising instance. Some time ago the south-western corner of Essex was much disturbed by the operations of an incendiary. A farmer in Sewardstone, about a mile from Gillwell Park, had had his stacks fired. The fire was indeed quenched, but the residue of the hay was completely soaked through with the torrents of water which had been dashed upon it, and was besides tainted with the smell of smoke. Cattle refused to touch it. We saw this damp, ill-smelling mass, apparently fit for nothing but to be thrown upon the manure-heap, put into the machine, and come out not merely dry, but freed from all empyreumatic smell. It was then readily eaten by cows and horses. We could not have conceived that the odour of burning, which every one knows is very persistent, could have been so simply and rapidly removed.

There is another conceivable objection, which caused the inventor himself to hesitate in the beginning of his experiments, but which has in actual working been found groundless—to wit, the danger of fire. It might be supposed that when the products of combustion are driven through a mass of hay, a spark might easily set the whole on fire. It must

be remembered, however, that the grass is fed into that part of the machine which receives the hot air directly from the furnace, and as it becomes drier it travels gradually on to the cooler parts of the machine. (See drawing.) Hence if a spark flies up from the burning fuel it is at once extinguished by the green matter with which it comes in contact, and



which thus protects the drier portions. In practical working no disaster from this or any other cause has ever arisen.

But this primary principle, the passage of the furnace products through the hay itself, would have been very inefficient without the mechanical arrangements by which the

material to be dried is automatically lifted up, tossed, and shaken in the current of hot air, and gradually passed on from the furnace end of the machine to the outlet end. This task is executed, as will be seen on reference to the illustration, by a series of tines fixed on cranks, and imitating simply, but most successfully, the action of the arm of the haymaker as he lifts up and spreads a portion of hay with his fork. It is an important point that this machinery though highly ingenious and to appearance delicate, is liable to get out of order.

The advantages of this process of machine-drying are very striking. Time and labour are saved to such an extent that the farmer will be able to get in his crops with his ordinary staff of labourers, and without the necessity of employing gangs of strangers, who are often careless, disorderly, and untrustworthy. So speedy is the action of the machine that at Neston Park, Wilts, the seat of G. P. Fuller, Esq., 30 tons of hay were made in twenty-three hours, at 13*s*. 6*d*. per ton, including the cost of mowing and stacking, though rain was falling frequently. In a second trial 33 acres were cleared in twenty hours, at a rather less cost, the bailiff in charge expressing the opinion that it will pay to use the machine even in fine weather. At Kimbolton Castle 7 acres of a heavy crop of clover were dried in seven hours by men who had had no experience with the machine at all. On Lord Ashburton's farm at Alresford, 19 acres of water meadow-grass were dried at 10*s*. 6*d*. per acre; whilst in an adjoining meadow a farmer cut his grass on July 15th, and after working at it by hand-labour till August 11th found it all spoilt. At Haarlem, on the farm of M. Amersfoordt, grass that had been cut for two days was made into hay *in five minutes*, and could be stacked with perfect safety. It must be remembered that the economy of labour, and the rapid withdrawal of the crop from the chance of damage by floods, &c., is not the whole of the benefit. The improvement in quality is most striking. Some time back, before the practical results of the drying-machine became known, Prof. Voelcker, F.R.S., expressed the following opinion in the "Transactions of the Royal Agricultural Society:"—"If hay could be made rapidly, without exposure to the sun's rays and the evening dews, it would contain much more nutrition than now." That this opinion applies to the machine-made hay is plain. It is of a bright green colour, of a stronger fragrance than ordinary air-dried hay, and is evidently preferred by all kinds of stock. Mr. Fuller wrote only a few days ago to the effect that twenty steers have

improved rapidly in condition since they were fed upon the machine-hay.

We have already referred to the fact that hay may now be saved in a sound condition which would otherwise have been spoiled and wasted. On this point it is interesting to hear the testimony of practical men. Mr. Roddick, of Quintain Hill, Waltham Abbey, says:—"Nineteen loads of damaged hay, which would otherwise have been useless, were rendered fit for stacking at the rate of 2½ loads per hour. I realised £60 to £70 by the day-and-half's use of the Hay-dryer." Mr. Mills says:—"Heavy, wet hay, black with decay and dust, came out a good, fair colour; the horses ate it freely. I estimate it as worth £5 a load in market, and have saved £20 by the half-day's work." Here, again, there may be something more than meets the eye. Damp, mouldy, ill-made or ill-kept hay has been recognised as unwholesome food for cattle. Now the moulds are minute plants, some of which are known to have a very injurious action if introduced into the animal system. The spores or germs of these moulds, and of other low organisms, are known to be present in the air and to attach themselves to grass. Hence men of science who have experimented on so-called "abiogenesis," or spontaneous generation, and those who have made microscopic organisms their study, have often selected infusions of hay as a material to work upon.

Now it strikes us as far from improbable that the machine-drying process, involving as it does exposure to a considerable heat in a current of carbonic and sulphurous acids, might prove fatal to many of these germs, and might thus contribute to the good health of stock and their preservation from epizootics, entozoa, &c. This point is, we think, not unworthy of experimental investigation.

So far we have given our attention exclusively to hay-drying. But the same principle, with certain alterations in mechanical details, is equally applicable to corn of all kinds, to seeds, coffee, tea, megass, malt, hops, and a variety of agricultural products. Thus for wheat the current of hot air is forced in below the false bottom of a sheet-iron chamber. From the false bottom there arise conical tubes, upon which the sheaves are fixed. A current of hot air is thus delivered up the centre of each sheaf, and, forcing its way out in all directions, rapidly dries both grain and straw. Peas, beans, &c., when dried by this process, retain, as may be expected, much more of their natural flavour than when air-dried. Peas especially may be kept for months, and when soaked and boiled taste as if freshly gathered. For

perfume-plants, pot-herbs, &c., the "Gillwell Dryer" has a future before it. The only decided failure which Mr. Gibbs has hitherto encountered has been in the attempt to convert grapes into raisins.

The least satisfactory feature connected with this invention has been the sluggishness of the public to accept the benefits offered. That the practical application of the principle to all the various conditions of the question did not suggest itself to the inventor in a moment may well be believed. To our personal knowledge Mr. Gibbs has devoted twenty of the best years of his life to perfecting his machine, simplifying its movements, and reducing the cost of construction. Those who know the expense of mechanical experimentation will feel little surprised if told that he has expended not less than £10,000 upon this his life-task. The Society of Arts awarded him their gold medal and 50 guineas in the very outset of his researches. The Highland and Agricultural Society of Scotland paid a similar tribute to his merit. The Press has given him its support, and not a few noblemen and gentlemen—we may mention the Dukes of Northumberland and Manchester, Lord Ashburton, and some of the leading landowners in many different counties—have adopted the Dryer, and expressed their unqualified satisfaction. But the great mass of the agricultural interest —landlords as well as tenant-farmers—still hold aloof, and allow their crops to perish, season after season, with an apathy that is rather ridiculous than sublime. That the inventor will yet be recognised as a great national benefactor, of more value to mankind than a score of orators and agitators, is certain; but the long delay is poor encouragement for inventors,

The agricultural interest has no cause to despair. Mr. Prout has shown them how wheat may be grown so as to pay, foreign competition notwithstanding; and Mr. W. A. Gibbs has taught them how their crops may be safely gathered in, in spite of unfavourable weather. Will they accept the lesson?

II. A GEOLOGICAL IDEA OF LORD BACON'S.

By Dr. O. Reichenbach.

(Concluded from page 533.)

THE soutnern ends of the three prototypic segments in Ps were not all moved away from Ps. The reflux of the excess of water round Ps tending in the deep towards the most attracting meridian, Pr of the nucleus traversed it with increased velocity, and produced gradually the greatest condensation and pressure of the envelope, and therefore the greatest accumulation of water round Ps V and its flow in the direction V Pr, to the point of greatest gravity in the equator. The opposite preflux from west to east, through the interval in the south of segment Pr, developed itself superficially by reaction. Segment Pr was therefore not only moved north; its portion south of 55° 8′ was moved towards Ps and beyond, and is divided into two sub-sections, of which the long axis extends through 46°56′+3°52′, the diameter of the polar circle plus a northern reaction wave.

This end of segment Pr, cut off in 55° 48′ S. lat., is all the Antarctic land there is. The segments Ap and Af have been wholly moved away from Ps by the reflux developing itself from the direction of segment Pr, south of 55° 48′ S. lat. on to long. 90° E. or meridian Af, with increasing velocity, and with a quantity regionally massed by the advance of the Antarctic land over Ps towards Ap.

The 1-11·56 of segment Pr thus cut off is less than 1-29·78 of all land, as 1 : 1·08, which should be the equivalent of elastic reaction north to south generated in the inter-stratum by heat produced through the falling advance of 1-29·78 of all the sea from south to north.

Suppose the south polar zone all sea, and plunge into it with Ps as centre a disk equal to 1·29·78 of all land; the disk has a radius of 10° 44′, and a series of oscillations of this width will arise in the sea all round, reacted upon and modified by oscillations 3° 52′ wide, over-reaching from the other hemisphere: 3° 52′ are to 10° 44′ as 1 : 2·73 as all southern to all northern land. We thus have modifications of the—

$$\frac{90^\circ - 3^\circ\ 52'}{2{\cdot}83^2} = 10^\circ\ 44' \text{ to } \frac{90^\circ}{2{\cdot}83^2} = 11^\circ\ 8' \text{ and } \frac{90^\circ + 3^\circ\ 52'}{2{\cdot}83^2} = 11{\cdot}35'$$

represented by peninsulas, isthmuses, islands, mountains: $2{\cdot}83^2$ is the extreme division of land in opposite hemispheres, and the proportion of the number of vibrations of their respective land masses, as shown by the comparison with blades. I exclude details about the difference between 2·83 and 2·73.

The height of a zone occupied by all land past from south to north, or in excess at the north, over one-half of all land, is $1\text{-}2{\cdot}83^2$ of the radius; what connects sphere and blades?

South America 10° 44′ from the antarctic circle has been moved and stretched 10° 44′ north of the equator; in the extremely tertiary reaction to 11° 35′. The triangle at its south reaching to the mouth of the La Plata, opposite the southern end of Africa, has been kept in a prototypic position by the reflux, its pressure being unimpeded below Africa. The northern end of the section has been widened from 31° 20′ in the equator to 46° 56′, the width of the tropics; the perturbation in longitude has increased with the increase of the polar arc and zone, with the separation and going apart in density of sea and envelope.

The long axis of the section and the bases from West Panama to Cape Horn are 66° 32′ as the arc from the polar circle to the equator. The east side is 55° 48′, the height between the equator and parallel of partition, because the triangle is pressed west, the northern side being by reaction from the north pressed south at its east, and north at its west, from the direction of V. The northern side, West Panama to La Roque, is 46° 56′.

The arc between the two Americas, at the east of the deutotype, is 46° 56′, the reflux halving the segment. At the west polar pressure has reduced the distance to 23° 28′. In this interval between the folds a tertiary perturbation has produced an island wave.

Trinidad, Cuba, Yucatan, which 10° 44′ north of the continent repeats its shape and its distance to the equator, is connected with the continent by an isthmus, the result of the combination of a perturbation in the reflux inclined 23° 28′ to the equator, with a perturbation in the polar stream or line of intensity, V, Pr, L.

The island wave and isthmus belong to the south section, and are, with its land north of the equator, equal to a polar section.

As the sea round Pn gets confined by the motion north of the segments, the region round Pn gets depressed, and the northern ends of the segments are moved south. Those of Ap and Af become truncated; the water pressing from Pr

towards L and beyond is thus reversed, at present chiefly from Obi and Lena, towards and beyond Pn, and circulates within the zone. Segment Pr has been thus not merely depressed from north to south, and moved toward S to the incline of 23° 28′ with meridian Pr, but its northern end has been cut off from west to east in proportion 1 : 4·78 to the middle section, as the southern end was cut off in the opposite direction. It became divided into islands. The normal latitude of partition 34° 20′ from Pn is indicated by 3° 52′ south of Cape Farewell by the junction of the waters flowing east and west of Greenland on their return towards the equator.

The more the segment increases in size and becomes inclined to the meridian, and the polar section itself increases, the more the latter gets similarly as at the south reversed in shape, the point south, the broad end north, until it penetrates like a wedge between the north middle section of Pr and the north section of Af.

The reflux dividing segment Pr is gradually raised to an angle of 34° 12′ − 3° 52′ (northern reaction) in the Gulf of Mexico by the projection north of South America, corresponding to the depression of the reflux south of Africa to 34° 12′ S. lat., and the land bulges out all along west of the line of intensity, S, Pr, towards the north.

The section reaches east of S by southern reaction 3° 52′ beyond the arctic circle. Thus reaches the Graham's group out of the antarctic circle, by reaction passing over Pn, Ap, and Ps; and the arctic section Greenland reaches 3° 52′ × 2 out of the arctic circle, pointing south, however shortened, a shortening for which volcanic Iceland is the equivalent.

The long axis of the south continent from near S to Cape Catorha and the basis S to Yucatan west inside Gulf are 66° 32′; the north and the east side are 46° 52′. From S to where the east side of the deutotype leaves the land we have 55° 48′.

The continent of the arctic section has a long axis of 23° 28′, and a peninsular prolongation of 3° 52′ at its north-east.

The Gulf of Mexico reaches 10° 44′ into the north section from the south; so does Hudson's Bay from the north, in reciprocity with the Siberian peninsula of Ap, reaching 10° 44′ into the arcttic circle, and 180° of longitude distant. Hudson's Bay, with James Bay, reaches 10·44 + 3° 52′ from arctic circle to South Florida, meridian Pr equivalent of James Bay.

The apocentric segment is inclined 23° 28′ to meridian Ap;

at the north it coincides with segment Af to the extent of $\frac{1}{29{\cdot}78 \times 2{\cdot}83^2}$ of all land. It has for basis L, Ap, V; its east is at the north limited by M, Ap, I, as that of segment Pr is indicated by V, Pr, L. It joins all through the north of segment Af, which occupies the prototypic position, and ocean circulation so is barred, reversed, and interned.

The more segments Ap and Af were moved north, and the former advanced together with the coinciding portion of Ap and Af into the arctic circle, and the cut-off and transforming end of Pr moved south, the greater became the pressure of the intervening sea from west to east against the north of Af. The north of Ap was therefore more advanced west to east toward S than the north of Pr is advanced toward L. Ap had for leaving west only half the room of Pr,—90° of longitude against 180°.

This reciprocity increased the pressure from north to south; the southern reflux became compressed in the deep, in the direction V, and all through until it had got past the southern and northern section of Ap in going west, when it again gained room for an expansion which not only pushed the southern section of Af most of all to north, but also to west, in reciprocity of the motion of the north of Ap to east. Segment Af so retained its prototypic position, and the western part of its southern section bulged out towards the interval dividing the pericentric segment. The west of its north section, divided from the south section by an ocean basin attaining to 34° 12′ + 10° 44′ latitude for the mean (Genoa and Adriatic), was stretched out and pointed to west by the sea reversed from Pr (respectively Panama), and formed the triangle of that large continent into which it became united, with the north of segment Ap as oblong. Af, more compressed from south and north, became the shortest, widest, and highest of the three segments.

The southern points of the three continental masses divide longitude from segment Pr west to Ap, and back to Pr $1 : \sqrt{2{\cdot}83}$, and from segment Af west to Pr, to remainder $1 : 2{\cdot}83$.

They also follow a regular progression in their distance from Pr. Segment Pr, freed from the antarctic land, is from Ps 23° 28′ + 10° 44′ = 34° 14′, leaving to the equator 55° 46′, the latitude of Cape Horn. Segment Ap should be from Ps 23° 28′ + (10° 44′ × 2) = 44° 56′, leaving 45° 4 to the equator, but Van Diemen's land reaches only to 43° 40′ S. lat.; the deficiency of 1° 24′ is at once corrected by New Zealand reaching beyond 45° 4′.

The middle segment should be $23° 28' + (10° 44' \times 3) = 55° 40'$ from Ps, leaving $34° 20'$ to the equator, $6'$ more than the $34° 14'$ from Ps to Cape Horn. Cape l'Agulhas reaches to $34° 55'$, $35'$ farther than $34° 20'$; the difference is that between the $10° 44'$ and $11° 15'$, making up for the deficiency at Van Diemen's Land. The west of Beagle Channel, north of Cape Horn, is from Ps as far as Cape l'Agulhas is from the Equator; the divide longitude 1 : 2·73 as land south to north in reality. The parallel of partition is moved to 53° S. lat., the mean latitude of Magellan Straits when the surface between it and Ps shall represent the 1-29·78 of all land really moved north of the equator from the southern half of segment Pr.

1-4·19 of all land moved south to north by the ocean accumulated over a more condensed interior have produced the relative land south to north 1 : 2·83. Quantities changed by tertiary causes to 1-4·25 and 1 : 2·73.

The prototypic segments have been moved from Ps to $31° 20'$ of longitude at the equator in front. (The longitude occupied by ocean within the $(31° 20' \times 3) = 94°$ of land formation in the equator is to the longitude of the actual land as $1 : (\sqrt{2 \cdot 83})^3$, and represents a tertiary perturbation, connected with perihelion position.)

The quantities moved are therefore indicated by the normal distances of the southern ends of segments from Ps, from which we afterwards have to deduct the quantities retained or transferred south by reaction from the north.

Segment Pr, initiating the transfer, had its polar end moved south towards and beyond Ps; it became reversed in form. Graham's Land points north as Greenland points south, and the first pointed end at Ps is now flattened between Ps and Ap.

Segment Pr moved from $55° 46'$ to where it still stretches, north of the equator, with a surface not only equal to a trune $31° 20'$ wide and $10° 44'$ high, equal to the triangle between Ps and $55° 46'$, the latitude of Cape Horn, but with a trune $11° 36'$ high, and equal to 1-29·78 of all land, or to the triangle reaching from Ps to 53°, the mean latitude of Magellan Straits, the channel indicating the parallel of partition, as the land from Cape Horn to the Chupat River $23° 28' + (10° 44' \times 2)$ from Ps indicates the return by northern reaction of land equal to the difference between a polar land section and the 1-29·78 of all land, the real return being only 1-480 of all land, and the antarctic section being actually 1-480 of all land smaller, and the middle section so

much larger, as required by proportion 1 : 4·78. At the north the conditions are the same, but in different form.

For Ap the normal line of advance fell 44° 56′ from Ps into 45° 41′ S. lat; the trune advanced north would be therefore 31° 20′ wide and 44° 56′ high.

For Af, closing the circuit, the trune passed north would be 31° 20′ wide and 55° 48′ high.

These three trunes, 11° 36′, 44° 56′, and 55° 48 high, represent 1-3·49 of all land. But as the land passes north, the ocean becoming confined in the extending arctic zone, and the excess weight of land pressing on the elastic substratum react increasingly from the land on the water hemisphere. The land retained and passed by reaction at and to the south is therefore equal to the land within the arctic zone, which is to that in and round the antarctic zone $\sqrt{2\cdot83} : 1$. It is 1-20 = 1-12·08 (polar zone to sphere) − 1-29·78 of all land. It is to the land actually past north as $1 : (\sqrt{2\cdot83})^3$ minus 1-480 of all land. It is when a, the land maintained south by reaction from the north, and b, the land actually passed north,

$a : (a+b) - \dfrac{b}{47\cdot77}$ (by tertiary reaction) as $\sqrt{1\text{-}29\cdot78} : 1 = : 5\cdot47$.

The ocean at the north is within a fire-warmer, waters having travelled from the north to the south in filters round Ps into the boiler below; the inner envelope is heated by pressure and friction turned into steam and presses land lifting towards the north, warming the water passing at the north over the bottom of the sea. The land raising north to south is a counter-process. The figures 1 : 5·47 have a varied significance for the present life of the earth.

The 1-20 of all land retained at the south by northern reaction is, after deduction of 1-480 of all land returning to Pr, divided between Ap and Af in proportion $1 : (\sqrt{2\cdot83})^3$.

All land of Pr south of the equator is therefore equal to half the segment, minus a trune 31° 20′ of longitude wide, with the equator as basis, and as high as the distance between the Antarctic circle and Cape Horn.

All the land south of the equator belonging to Af is equal in surface to the triangle between Ps and the parallel of Cape l'Agulhas, the southernmost point of the segment in 34° 55′ S. latitude.

The portion of segment Ap between Ps and Van Diemen's Land in 43° 40′ is equal to the Australian continent. The triangle between Ps and the south of this continent in 38° 40′ is equal to all land of segment Ap south of the equator.

The separation of the south section of Ap from Van

Diemen's Land in the south, New Guinea in the north, and New Zealand in the east (the latter by reaction from Africa), and of smaller islands, shows distinctly how land moved north has been by tertiary reaction cut off from the main section or continent, and how interference folds have been formed in the intervals through pressure from the north.

When we start from Pr at the equator, and the north shore of South America at its east, and proceed over Pn on the same circle to Ap, we find at its east an island wave which extends and points south 10° 44′ at South America, extends and points to 10° 44′ north, whose organisms present the characteristics of the Asiatic, northern section, and which separates from the southern section New Guinea and smaller islands whose organisms present either the Australian characteristics or a compound nature.

When we return over Ps, back to Pr and beyond, we find 10° 44′ north of the shore of South America the tertiary wave, Trinidad, Cuba, Yucatan, closing the circuit,—a wave which, with the supplementary isthmus south, is equal to all non-Australian land between the equator and continental Australia, and which, adding the volcanic south of Mexico, is equal to all land between the equator and Australia proper.

Segment Ap is divided not in four, but in two parts, in proportion $1 : (\sqrt{2 \cdot 83})^3 = 1 : 4 \cdot 78$.

The middle segment is divided north to south $1 : 2 \cdot 83$: it reverses, closing the circuit, the relation of the hemispheres. Subsections, and the contiguity of the north section with Ap, are here extensively to be considered.

The east limit of segment Ap, between the two continental sections, is like at Pr from South Carpentaria, 46° 56′; the west limit, south of Sumatra to Australia, 23° 28′. The east limit of the segment, north to the meridian dividing Af, is 66° 32′.

Ap stretches 10° 44′ into the arctic circle, and measures from Lunk Leylon to the north or meridian Ap 66° 32′.

The axis through the middle of the southern section of Af, on the meridian dividing all land and sea equally, is 66° 32′; that through the north section is 23° 28′, plus 3° 52′ in the arctic circle occupied by the coincidence of Af with Ap.

The readers of Mr. Russel Wallace's "Island Life" may observe the relation between my sections and the distribution of organisms. This relation becomes still more striking when subsections and the lines of intensity are considered. There exists an intimate relation between the distribution of gravity, and of consequent motions and oscillations of sea

and land, and their history with the past evolution and present distribution and condition of organisms.

In my theory the explanation of real and apparent changes of climate offers no difficulties. Climate has changed absolutely with the development and condensation of the solar system and of our earth. It has changed with the changing positions of the axis of the earth on its orbit,—that is, with the raising and permanency of continents and the distribution of sea and land, with the folding and unfolding of solid waves sliding, and with the whole envelope sliding in procession.

III. LATENT HEAT.

By Charles Morris.

SCIENTISTS have a somewhat misleading method of grouping together several widely different modes of motion under one name,—not to their own confusion, perhaps, but decidedly to that of unscientific readers. Thus, after singling out a few forms of force under special names, all the rest are massed together and called heat. It is true the special character of the force intended is indicated by adjectives. Thus we speak of Radiant Heat, Specific Heat, Latent Heat, Absolute Heat, and, simply, Heat. Of these the first phrase is most commonly used, and is most incorrect. It expresses a mode of motion which is essentially different from Heat motion. It is readily convertible into Heat, but so are Light and Electricity, and the simple word Radiance would perhaps be a better term for it.

The word Heat itself, in fact, does not express one single mode of motion, since the heat motions in solids and gases are very different in character, while there is reason to believe that liquids also possess a special mode of heat motion. So Specific Heat, Absolute Heat, and Latent Heat have special significations, which scientists have no difficulty in comprehending, so that the word Heat to them expresses far more than it does to well-informed unscientific readers. Of these various terms Latent Heat is the one least understood,

and some writers deny that the force condition which it indicates is in any proper sense allied to Heat, and claim that it should be expressed by some distinctive word.

Yet these writers have given no satisfactory hypothesis to the contrary, and it remains probable that Latent Heat is but a special modification of heat energy. I have already briefly given my views concerning it, in the April number of the Journal, but will here partly repeat them in order to deduce certain important and interesting consequences of the principle of Latent Heat.

Latent Heat, in its usual signification, is the heat which disappears when the solid is converted into the liquid, and the liquid into the gaseous form of matter, and which reappears in the reverse process. Yet it has a much wider significance than this, since these radical changes in the condition of matter are by no means necessary to its existence. Every apparent loss of heat in change of material condition is a conversion of sensible into latent heat. Thus as solids and liquids grow hotter their Specific Heat is said to increase. By this we mean that it takes more heat to produce a certain temperature effect at high than at low degrees of temperature. Part of the heat disappears, or becomes latent; or, in other words, it needs different volumes of heat motion to produce unit effects of temperature when matter is in different states, or in different temperatures of the same state. But this gives us no just reason to conclude either that motion has gone out of or come into existence, has changed into something that is not motion, or has lost its centrifugal and assumed centripetal relations. It may continue to exist as centrifugal motive energy, and fail to make its existence felt as vigorously in high as in low temperatures for some sufficient reason.

This reason, as considered in my article above referred to. may be a mere difference of resisting energy in the molecules of matter. The effect of a blow does not depend solely on the weight of the stick, but partly on the energy of the muscles which wield the stick. So a molecule which is strongly bound by attraction to other molecules, or vigorously wielded, as we may say, by other molecules, strikes a heavier blow than one which is weakly bound or feebly wielded. The first represents a moving stick with a strong arm behind it; the second, the same stick with a weak arm. The blow of the first receives much more exterior aid than that of the second, and is therefore more effective. To produce equal effects the stick wielded by the weak arm must have greater weight, or must have a more vigorous original motion of its

own than is possessed by the stick wielded by the strong arm. If it fails to receive equal energy from without, it must possess greater energy in itself. This is the whole secret of latent heat. Molecules are partly individuals and partly constituents of a more or less rigid whole. They are in incessant motion, and come into very frequent contact with each other. By equality of temperature we mean that these molecules strike each other with equal energy, and resist repulsion with equal energy. But for this equality of effect it is not necessary that their individual motive energies shall always be equal. For if they are parts of a rigid mass their strength of resistance comes only partly from themselves, partly from their fellows. But as the mass loses rigidity each molecule receives less and less aid from its fellows, and has to depend more and more on its individual vigour. Each molecule is attached by attraction to its neighbours, as if it occupied the centre of an elastic band whose ends were firmly fixed. The more rigid such a band, the less individual energy would be needed by the molecule to give it a unit vigour of resistance. The less rigid the band, the more individual energy would be requisite. Two molecules of equal weight strike each other with equal speed. Their momentums are equal, and they should recede with equal energy. But one of them is firmly held by links of attraction to surrounding molecules, while the other is but weakly held; therefore the first cannot recede without dragging a number of others with it, while the drag of the second is much less. Thus the receding energy of the first, being resisted through its rigid connection with many others, is much less than that of the second, which is less resisted. The first molecule imparts more energy to the second than it receives in return, or, in other words, the temperature effect of the first exceeds that of the second. The temperature effects of the two can only be equalised by giving the second more motive energy, or increasing its individual momentum. And this excess of motive energy is what we know as Latent Heat.

We have the whole mystery here. As attractive energy between the molecules diminishes, each of them needs more individual motive energy to give it equal resistance to impact. This applies to all the molecules of a mass, and therefore the whole mass needs more heat motion to produce unit temperature effects as its internal attractive vigour decreases. But the result of heating a solid mass is to decrease the vigour of attraction between its molecules. It expands with increase of temperature, and becomes less rigid. As a

consequence its specific heat increases, or a portion of its heat becomes latent, or, in the terms of this hypothesis, each molecule, and therefore the mass as a whole, needs more individual heat motion to give it a unit resistance to exterior heat impact.

When solids are far from their melting-point this effect is slight, as they decrease very slowly in rigidity. Thus it is inappreciable in platinum at ordinary temperatures, since this metal is then very far from its melting-point. But as solids approach their melting-points the increase in specific heat becomes declared. It is especially marked in those solids which soften before they melt, and it thus shows its relation to decreased rigidity. On melting there is a very considerable increase of specific heat, and particularly in those substances which continue rigid to the moment of melting. In passing from the last degree of solidity to the first degree of liquidity the specific heat suddenly becomes very great. But the rigidity very greatly decreases, so that the two effects continue in accordance. The molecules of the liquid have to depend far more on their individual energy than do those of the solid, and are thus obliged to absorb a considerable volume of motive energy to put them into temperature equilibrium with the solid.

The same rule holds with liquids as with solids. As they slowly expand with heat their internal attractive vigour decreases, and their specific heat increases. On changing to the gaseous state there is another sudden decrease of rigidity. The attractive control of molecule upon molecule very markedly decreases, and there is a sudden and enormous increase of specific heat in the degree of temperature leading from the liquid to the gas. The molecules have become strongly individualised, and need a great increase in motive energy to place them in temperature equilibrium with solids and liquids. The same principle holds good with gases. As their temperature rises above the point of vaporisation the attractive energy between their molecules probably continues to decrease, and their specific heat increases. When, however, their temperature is considerably above the point of vaporisation, the specific heat becomes constant. It is presumable that their rigidity has also become constant, as in solids when far below their melting-point.

This is latent heat in its ordinary acceptation. There is no real loss of heat energy, and no transfer of motive vigour from the centrifugal to the centripetal field. All the heat energy received continues to be energy of molecular impact, and it increases in relative amount to the exact degree that

resistance to impact decreases in energy, through molecules being more and more obliged to depend on their individual motive powers, and less on assistance from their neighbours.

But latent heat presents other phenomena, which it is necessary now to consider. Thus we find the specific heats of solids and gases are closely similar, while the specific heat of liquids is considerably greater than that of either solid or gas. How is this to be explained ? Must we consider that liquids decrease more rapidly in rigidity with increased heat, or can we conceive of any other cause ? The first explanation is hardly probable, and it may not be difficult to deduce a better one. It seems more probable that this behaviour towards specific heat of the three forms of matter points to a certain similarity in motive condition between solids and gases, and a diversity in liquids. That the conditions of heat impact in solids and gases have a strong similarity we are well assured. In both cases it is direct impact of molecule upon molecule, these being free moving molecules in the gas and vibrating molecules in the solid. But it is very doubtful if this condition of direct impact exists in the liquid. If, as the writer is disposed to consider, the liquid state of matter consists in rotation around a centre of attraction, instead of a vibration between local attractions as in the solid, its motive energy becomes to some degree centripetal. Rotating particles could not meet the impact energy of solid and gaseous particles by a reverse impact, and their resistance must partake of the nature of elasticity. They must retain their curves of rotation with a degree of inertia, whose vigour depends on the energy of central attraction, and must thus oppose an elastic resistance to the impact energy of exterior molecules. But the rate of decrease or increase with temperature of an energy of this kind might be very different from that of impact energy, and thus the specific heat be very different. In the illustration already given of a molecule attached to the centre of an elastic band, we would have, in the molecule of the solid, the double resistance of the elasticity of the band and of its own moving energy ; in the liquid molecule the elasticity of the band only, since here the moving energy virtually converts the molecule into such a band. Possibly, then, the resistance of the molecules of the liquid would decrease more rapidly than that of the molecules of the solid and the gas, and its specific heat would be greater in consequence. The heat energy, which is a centrifugal motion in the solid and the gas, may become partly or wholly a centripetal motion in the liquid.

But our review of latent heat by no means stops here.

There are other instances of great increase and decrease of attractive energy to be considered. Thus chemical integration produces an immediate and great increase of attractive vigour between particles. There is, therefore, a marked increase in resisting vigour, and much less heat is needed to yield unit effects of temperature. The excess heat of the compound flows out as active heat energy. It is no longer needed by the combining particles, and becomes effective elsewhere. In chemical disintegration this effect is reversed. There is a marked loss of attractive vigour between the separating particles. They become greatly individualised, and must absorb considerable motive energy from without to bring them into temperature equilibrium with surrounding matter. Or, in the usual phraseology, in chemical integration much latent heat becomes sensible; in chemical disintegration much sensible heat becomes latent.

There remains one other phenomenon of latent heat to be considered. We have so far viewed the latency of heat as a result of decreased internal resistance, arising from the gradual or sudden decrease of attractive energy between molecules. But a like effect may arise from another cause, that of increase or decrease of external pressure. This action, while of little effect upon solids and liquids, is very effective upon gases, and causes marked changes in their heat contents. If gases be greatly compressed a considerable volume of their latent heat becomes sensible. If they be greatly expanded a considerable volume of their sensible heat becomes latent. In the first case their temperature markedly rises; in the second it as markedly falls. The result here seen is in strict accordance with the principle above enunciated. The compression of a cubic foot of air into a cubic inch of space may not necessarily increase the vigour of attraction between its molecules, but it must increase the effective energy of these molecules. The surface against which they strike is only 1-144th its former extent, and thus the impacting energy of the molecules is concentrated upon a much smaller space. They need less absolute heat to produce the same temperature effect as before, and their excess motive energy is yielded as sensible heat. In the case of expansion the surface upon which the molecules act is increased in extent, and their motive energy must be augmented to yield an equal effect. It is also possible that the results arising in these two cases may be aided by a variation in the effective vigour of intermolecular attraction, this increasing in compressed vapour, and decreasing in expanded vapour. This last mode of varying the degree of

latent heat, or increasing or decreasing the absolute heat contents of fixed quantities of matter by rarefaction or compression, has a very important cosmical significance, as we shall proceed to show.

The matter of space must, for two different reasons, possess a much greater absolute heat than the matter of the spheres. It is, in the first place, excessively more rare than the atmospheres of suns and planets. But, as we have just seen, gases become cooled by rarefaction, or, in other words, their absolute heat for equal temperatures increases. In the second place, the matter of space is in a more disintegrated condition than that of the spheres, and perhaps, to a considerable extent, completely disintegrated. But chemical disintegration also increases the latent heat contents of matter, or its absolute heat for equal temperatures. Thus the absolute heat of the matter of space must, for these two reasons, far exceed that of the matter of the spheres, if their temperatures be equal; or, if their absolute heats approach equality, the temperature of interspheral matter must be greatly reduced below that of the spheres.

Let us apply these conceptions to the case of the contraction of a nebula from its original diffused condition to the final state of a solar system. Our own solar system, in its nebulous state, was an excessively diffused gas, its material much more homogeneous and disintegrated than at present. If we assume that this nebula was of equal temperature throughout, then its heat contents must have approached equality. Equal temperature now between spheral and interspheral matter would indicate a wide difference in absolute heat contents, but in the matter of such a diffused and nearly homogeneous gas it would indicate but little difference. It is exceedingly improbable, therefore, that the matter of the primitive nebula was at a high temperature, or that it was a glowing gas, as so often assumed. Its high degree of latent or absolute heat could be only consistent with a low temperature, and very probably this temperature was considerably lower than the average of that of the earth's surface at present, for its condition must have more nearly approached the present condition of interspheral than that of spheral matter. It was, in effect, a vast sponge, filled with heat, which heat has ever since been pouring out, as gravitation has squeezed the sponge into smaller dimensions. The original heat of the sponge was in great part latent. Compression has rendered it in great part sensible.

Assuming, then, in the doctrine of the nebular hypothesis, that the primitive state of the solar system was that of a

diffused gas, with a considerable degree of homogeneity, with a temperature largely equalised, and therefore with a considerable accordance in its absolute heat contents, what effects would condensation produce on its heat relations? In considering the evolution of the solar system, scientists have attended principally to the physical aspects of the case, and but little to the force aspects. Physically we are presented with two marked results. One of these is a continued condensation of the principal mass of the matter of the nebula, and its aggregation into dense globes. The other is a continued rarefaction of the remainder of the nebulous matter, ending in the production of an excessively rare and highly disintegrated interspheral matter.

But such a process must have been accompanied by a great disturbance of the heat relations of this matter. As condensation continued, latent heat must have become sensible continuously, and the temperature of the contracting spheres must have greatly increased. And as rarefaction continued sensible heat must have become latent, and the temperature of the rarefying matter have considerably decreased. Also, condensation must have been accompanied by continual chemical integration, and rarefaction by chemical disintegration, thus considerably augmenting the above results. Thus the original partial homogeneity of temperature may have become a great heterogeneity, without any necessary disturbance of the original equality of absolute heat contents. The difference in temperature would be caused simply by the latent heat of the contracting substance becoming largely sensible, and the sensible heat of the rarefying substance becoming largely latent; the one being, therefore, in ordinary language, greatly heated; the other, greatly cooled. The final result has been, then, to replace the original partial equilibrium of temperature of the nebula by an extreme diversity of temperature between the matter of the spheres and of space, this great difference in temperature not, in itself, requiring any difference whatever in the absolute heat contents of these two conditions of matter.

Two necessary consequences arose from this evolution of a solar system. One was a steady increase in temperature of the central sun, which was not probably balanced by its heat radiations. This increase may still continue, and may continue for ages to come, for the radiations of the sun may not equal its increase in temperature through condensation. It is quite possible, then, that the sun, instead of cooling off, is yet growing steadily hotter, the sensible heat yielded by compression only slowly reaching its surface and outflowing

into space. The other consequence was a continuous effort to reproduce the lost equilibrium of temperature. This is a process which has continued for ages, and must do so for long future ages. The equilibrium which may have existed originally has been completely overthrown by the parallel condensation and rarefaction of matter. By the process of heat radiation Nature is seeking to produce a new equilibrium. This may eventually succeed, but can only do so by producing an excessive diversity in the heat contents of matter, since equilibrium of temperature between the dense matter of the spheres and the rare matter of space must signify a vast inequality of absolute heat.

(To be continued.)

IV. ANIMISM *versus* HYLOZOISM.

By J. H. Barker, M.A.

" God is light."—St. John.
" He that built all things, is God."—St. Paul.

ALTHOUGH I might fairly object to the *Dualism* of my critics, as exemplified in Dr. Lewins and his shadow C. N., yet as I love truth, whether in Religion or Philosophy, and as they court investigation, and are evidently actuated by the same spirit, I will reply candidly to C. N.'s article in the September number, without pledging myself to carry the discussion any further.

I believe I am doing no injustice to C. N.'s Hylozoism if I say that it regards Matter, consisting of an infinity of solid atoms, as the only Reality; that what we call Mind is nothing but a motion or function (a most vague and ambiguous term) of some of these atoms; and that they have existed from eternity. This is a revival of the old Atheistic doctrines of Democritus, Lucretius, &c.; and it will suffice to pit against them Seneca, Plutarch, Cicero, and especially those princes of heathen philosophy, Plato, Socrates, Xenophon, Hesiod, Epimenides, Xenophanes, &c.

This necessarily involves the conclusion that all mental processes, even the most complex,—all moral affections and emotions,—all imagination and poetry,—all knowledge, even the highest and noblest,—all the sublimest conceptions of the human mind,—are nothing more than the motions of solid atoms!! And this (I must call it) degrading view of human intellect is said to be Science, in the nineteenth century! But let us calmly examine this monstrous idea.*

If such are indeed the "inalienable" prerogatives of matter,—if it can, *of and by itself*, think, feel, choose, and calculate,—then it is what men in general call *mind;* and I hardly know whether the confusion of thought thus manifested, or the confusion of language, is most to be condemned. We have no data, no common ground for reasoning. We know not what we are talking about.

C. N. *assumes* that the Lucretian doctrine—of matter being composed of an infinity of solid atoms—is undisputed and indisputable. To say nothing of the visionary Idealism of Berkeley, derived from Oriental myths,—has C. N. never heard of the Physical hypothesis of Boscovich, as set forth in his "Theoria Philosophiæ Naturalis"? He maintains—upon the plausible ground that our bodily senses inform us of nothing more than phenomena, the actual causes of which are unseen Realities—that Matter has no objective existence at all; but that all the motions and properties usually ascribed to matter, can be logically accounted for, by assuming the existence of an infinitude of *centres*, from which emanate forces of various intensities, as well as of diverse kinds. By this view, therefore, Matter as an objective reality is wholly dispensed with; and the sceptic who denies the existence of mind as a distinct entity, finds himself confronted by "a scepticism still more sweeping, and reasoning still more refined than his own." Granted that both theories are inferences,—for they can be nothing higher,—still *mind* is demanded to form the inferences; so that the Materialist is fairly stranded; he can make no way, except by the recognition of the prior existence of Mind. It must not be supposed that I adopt Boscovich's theory. But I say, with confidence, that if the question is to be decided upon logical grounds alone, it is not Mind, but Matter, that is in danger of going to the wall.

Again, I ask, What is Reason, if it is not a faculty of

* On the general subject of spiritual realities I may refer C. N. (without saying that I accept all their conclusions) not only to Cudworth, but, in our own days, to the authors of "The Unseen Universe" and Fiske's "Cosmic Philosophy."

Mind? It cannot be a faculty of a solid atom, or molecule, or of a drop of water, or even of a living plant. Can these forms of matter reason, or draw inferences? Man, and perhaps also the higher classes of animals, *can* do this. And if so, surely no 'mens sana in corpore sano' can doubt the existence in these organisms of something which can deal with matter, and is therefore superior to it. The Materialist, then, who ventures to reason on the subject, first tacitly assumes that he *has*, or (more strictly) *is*, a '*mens sana*,' and then turns round and formally denies it. He cuts away the branch on which he sits, and the result is somewhat inconvenient.

The truth is, that C. N., and those who think with him, draw a wrong inference from an admitted truth, viz., that it is a law of our present economy, that one mind can only manifest itself or its working to another mind, by being embodied in matter. Moreover, it may possibly be a general law of all finite beings, that a material vehicle is a prerequisite to inter-communication of any kind. But this, if it be so, in no way proves that body and mind are not two distinct entities, blended rather than united, and mutually affecting each other.

Let me now point out another fallacious inference. Hylozoic Materialism, we are told (p. 521), maintains "the inherent vitality or energy of Matter." This appears to be borrowed from Strauss, who says "Life is only a special, viz., a most complicated, form of mechanics." Even could this be proved (which it cannot be), the whole tenour of C. N.'s articles show that he bases this theory on the allegation that Science has proved that every atom of matter is in constant motion, in one way or another.

Well, be it so. I do not deny it. But what then? This does not prove matter, *per se*, to be *alive*. Such a conclusion destroys all distinction between *life* and *motion*. Besides, this fact (if it be one) is at least as logically explained by the hypothesis of an ever-present acting Mind,—a personal though invisible Being, the all-wise Maker and Ruler of the world.

What conclusion can be more 'lame and impotent' than to say that a thing is *alive* because it moves? You must prove that it is *self*-moving, before you can prove that it is alive. Is a stone alive, because it moves when thrown by the hand of man? Does it choose its own course? or is it the human *will* that chooses it?

With respect to the (so-called) *axiom* of modern Science (p. 522), all that Science pretends to show is, that no portion of matter is in a state of *absolute rest*. It does not, and

cannot, deny that atoms may at times be *relatively* at rest.

C. N. having thought it desirable to repeat the argument respecting children and savages, I must revert to it in still plainer terms than those used in my last letter. Such reasoning, if it proves anything, shows that Materialism would bring us back to a state of mental barbarism and childishness, and limit our conceptions to that which is visible and tangible. It is virtually a retrograde movement, however 'advanced' its advocates may fancy themselves.

In p. 523 we have the following singular piece of reasoning:—"Except on the principle that the half is more than the whole, I do not see how a perfect being can be inferior to an imperfect one, and the very word 'immaterial' implies defect and limitation." Here *body* is called a perfect whole, and the *soul* an imperfect half. But the term "immaterial" implies no defect or imperfection; it simply means *not* material, and, as far as the word goes, may mean unlimited superiority to matter. If by "our physical structure" is meant our whole animated nature, I fully admit that it *is* capable of thought and sensation. But when the 'anima has quitted it, the body is a carcase, incapable of either.

In the same page we read, If *will* be destitute of dynamic power, it is a nonentity, an illusion." 'Will' *is* certainly a nonentity, for it is not mind, but the *working* of mind; and who ever calls *working* an entity? And who is there that is not conscious, ofttimes, of having the *will* to act, without the power to do so?

The motions referred to at top of p. 524 appear to me to show that the brain is not the only organ by which the mind acts, but that it is associated with the whole nervous system. Automatic motions imply, not the absence, but rather the presence of (unconscious) mind. All they show (in paralysis) is the suspension of the mind's control over the neuro-electric stimulus which affects the muscles. The actions of sleep-walkers decidedly prove the presence of mind, and of many of its faculties, though not that of consciousness.

We are further told (p. 524) that the *vis insita* of matter etymologically means an *indwelling*, but practically an *inalienable* force, which supplies the place of the Divine afflatus, and affords a logically sufficient 'cause.'" I grant that it may be the proximate, but not the independent and primary cause. It is itself an *effect*, as the word *insita* (as used by Newton) shows. For it does not signify *indwelling*, but *inserted* or *implanted* (the passive participle of the verb *insero*), and implies, what Newton always maintained, a Being who

implanted it. And this affords me an opportunity of illustrating what I mean by a *chain of causation.* The several actions stand thus: — The Deity—Will—Force—Motion. God exerts his Will, producing Force, which, when acting upon Matter, results in its Motion. I contend, therefore, that the Divine *afflatus* (by no means a happy phrase) is not superseded by this *vis insita*, but is equivalent to it.

The analogy suggested with relation to phlogiston and oxygen is fallacious. If phlogiston was supposed to be a "levitating factor," expelled by heat, while oxygen was a *gravitating* one, absorbed by the metal when calcined, it does not follow that such a substance as phlogiston *could* not have existed. If there were a form of matter lighter than air (*e.g.*, hydrogen), and it could have united with a metal without being condensed into a solid (as oxygen is in an oxide), while so united it would have made the metal lighter (in air) than when driven off from it. It is not so, in fact; but the possibility of it wholly vitiates the analogy here suggested, beside that no one supposes that the 'anima' is subject to gravitation. The subsequent assertion that certain *truths* have been corrupted into Dualism, is nothing better than a *notion*, and a very unfounded one too.

I beg to say, that I do not misapprehend the illustration taken from odours and poisons, but I deny its appositeness. *Why* combinations of the same elements in different proportions, when brought into contact with our nerves or senses, affect them so differently, it is impossible to say. I believe it to be an arbitrary appointment. But how totally different are the uncertain actions of a voluntary being from the definite effects of chemical compounds upon other matter!

In answer to the remarks in p. 525, upon animal life being the "outcome of certain chemical changes"—if the ambiguous word 'outcome' means 'initiation,' I ask, with confidence, What chemist has succeeded in producing a living organism except through the agency of previously existing life? The inferences from the late Mr. Crosse's electrical experiments were soon entirely abandoned.

Passing over the unseemly flippancy of the remark about a "ghostly Archæus," I fully admit the influence which alcohol, opium, &c., exert upon the mind through its material associate, the nervous tissue. But instead of this being a case of the "fiddle playing on the musician," it is one of a broken fiddle producing sounds quite different from a well-tuned one. The musician has (perhaps wilfully) damaged his fiddle.

With regard to the quotation from Dr. Lewins, I see little

difference between the "*anima mundi* and *anima humani*" being fundamentally the same, and "the question being the same."

C. N. seems to think that he has caught me on the horns of a dilemma, when he observes (p. 525) "An Infinite Mind 'giving existence to finite minds' must be limited by its own creations, and therefore be at once infinite and finite. Here again, I hold the premiss, but deny the conclusion. An Infinite Mind must be able to do anything which is not a self-contradiction. And if it sees fit to create finite minds, and *to give them the liberty* of even opposing itself, this is not parting with infinite power, but only voluntarily holding it in abeyance.

In p. 526 we read "If there be an *omnipresent* Deity, nothing else can have any real existence, and he must be the noumenon of which the Universe, subjective and objective, is the phenomenon." This is again a '*non sequitur.*' If God were matter, the admitted axiom that two portions of it could not occupy the same space, at the same time, would be applicable. But this would be a *petitio principii.* For what right has the Materialist to assume that no Reality exists but what is material? It is a naked assumption (contradicted by our own intuitive consciousness), which vitiates all his reasoning. And I maintain that it signifies *everything* whether we call the Supreme Reality a "God, Force, or Matter." I can hardly imagine a more convincing proof of the confusion of thought engendered by Hylozoism than such an absurd dictum.

I pass over the unintelligible sentence about Egoity and subjective Cosmos, to repeat my denial that the believer in an Omnipresent God is logically compelled to Monism—if by that term is meant the exclusive existence of one single entity, and that entity, Matter. Such an assertion may well be left to the common sense of ninety-nine out of every hundred readers. But I am no Pantheist. My Omnipresent God is a Being immanent in all things, though in a manner wholly inscrutable (not unknown or unthinkable) to our finite minds. He is as truly personal as our own minds are, though He immeasurably transcends them; and He has given our minds (or souls) the capacity of self-improvement and development, in order that we may, if we will, become more like Himself in goodness and in truth.

[In accordance with the wishes of many of our readers we must decline any continuation of this discussion.—Ed. J. S.]

V. THE SANITARY LEGISLATION OF THE PENTATEUCH.

STRANGE as it may sound, legislation concerning public health is not entirely a notion of this nineteenth century, sprung from the brain of the Southwood Smiths and the Chadwicks. Ages before the Society for the Diffusion of Useful Knowledge or the Sanitary Institute of Great Britain came into being we find regulations on sanitary subjects not merely proposed but formally enacted, invested with the most solemn sanctions of religion, and inseparably interwoven with the customs and polity of a remarkable people. These regulations, which have attracted surprisingly little notice considering that they are met with in a Book which has, more than any other, been closely scrutinised, both by its friends and its enemies, are, we think, not unworthy of attention from a scientific point of view. They agree most strikingly with the results of modern research, both in the recognition of danger and the precepts laid down for its removal or avoidance, and they are in too many respects far in advance of our actual practice. We propose to examine these laws, not from the position of the archæologist, the orientalist, or the divine, but simply from that of one interested in Sanitary Science. If we find that Moses has anticipated certain of our modern oracles we shall not seek to explain so suggestive—and to some persons unwelcome—a coincidence. The question whether or no some of the laws which we shall quote may not also have other and possibly even higher meanings we must leave to be discussed elsewhere. We think meantime that no one who has carefully traced the history of the human mind need feel surprised or offended at finding precepts on bodily health presented as under Divine sanction.

We will first call attention to the subject of blood. Nothing is more emphatically and repeatedly forbidden in the Books of Moses than its use as an article of food. What is the reason of this prohibition, which, as most people know, is very scrupulously obeyed by the Jews down to the present day? Theologians will perhaps pardon us if we submit that this has, in addition to other possible meanings, a physiological import which has in these days been too frequently lost sight of, even by many medical men.

The enactment is surely in complete harmony with the teachings of modern science. We know that the circulatory system has a double office: on the one hand it serves to convey fresh matter to supply the wear and tear of the system, whilst on the other hand it serves to carry off what may be popularly called the waste or refuse of the body. Such refuse is in due course eliminated by means of the kidneys, the sudiparous glands, &c., and appears then in its avowed character of excrementitious matter. It is therefore evident that the blood if drawn off promiscuously, arterial and venous together, contains a certain proportion of effete substances which are only fit to be expelled, and which are ill-suited for human food. If by any derangement the action of the kidneys is arrested, this refuse accumulates in the blood, and the consequences at once make themselves felt. Now as to separate the arterial from the venous blood of a slaughtered animal is impracticable, we contend that to use the blood as food approximates very closely to drinking urine, and is not merely loathsome but *pro tanto* unsafe. That, like liquid and solid excrements, it is valuable for plant-food, and that it serves as a pabulum for certain classes of animals, is no proof that it is fit for human consumption.

Even the mechanical state of blood when coagulated is a strong argument against its dietetic use. Unlike flesh, it is not composed of fibres between which the gastric juice can easily penetrate. It is a solid structureless mass like caoutchouc, which can only be acted upon from the outside of each fragment, thus rendering the process of digestion more difficult.

Turning from theory to practical experience, we refer to the higher value—in an actuary's sense of the word—of Jewish lives than of those of their Gentile neighbours inhabiting the same locality and engaged in avocations little different. Is not this recognised superiority on the part of the Jew due, in part at least, to their hereditary avoidance of blood during the course of three thousand years?

It is generally admitted that the internal organs of animals—such as the kidneys, the liver, &c.—are of questionable value as articles of food. They are, as we learn from carcase-butchers, very frequently in a diseased state, and are apt to be the seat of entozoa. We have not succeeded in ascertaining whether these parts are avoided by the Jews at the present day. But the law seems perfectly clear (Leviticus, iii., 15, *et passim*) that in all cases of beasts sacrificed the "inwards" must be destroyed by fire.

The disposal of blood did not escape the attention of the Israelitish law-giver. Directions are given that it is not to be let stagnate on the surface of the ground and there putrefy, but to be "covered with dust" (Leviticus, xvii., 13), or, in other words, absorbed in dry earth. Hence it seems fair to conclude that more than three thousand years ago the peculiarly offensive character of putrescent blood and the deodorising and disinfecting property of earth were known. Covering with earth is also the treatment specified for excrementitious matter. To the present day nothing is more offensively striking, wherever large numbers of human beings are collected away from their settled habitations, than the accumulation of filth which defiles the neighbourhood. Not merely sieges and other military operations, but engineering undertakings, fairs, camp meetings, pilgrimages, are characterised by nuisances of this nature, which doubtless assist in the propagation of typhoid fever, cholera, dysentery, &c., if the germs of these diseases are introduced. But Moses (Deut., xxiii., 12) gives special direction that excrement shall be dug into the earth. Indirectly this may be regarded as a prohibition against casting filth into the streams and watercourses. This view will appear strengthened by the decree that the falling of dead animals into small bodies of water (Levit. xi., 36) caused them to be regarded as unclean.

But whilst the use of blood as food is decidedly prohibited, and whilst its absorption in earth is enjoined, it figures in another capacity which has also a sanitary phase. It has been suggested to us that the application of blood to the doorways of the houses of the Israelites (Exodus, xii., 22 and 23) was not merely a symbolical act but a prophylactic measure. The destruction recorded as coming upon the Egyptians was probably some zymotic disease, the proximate cause of which would be morbific bacteria in the air. It is represented to us as not improbable that these bacteria, or other microbia, would be attracted and absorbed by the fresh blood sprinkled on the doorposts. This view of the case is fortified by the enactment that the Israelites were not to leave their houses in the morning. We are very far from presenting this supposition as demonstrated. But we understand that slaughtermen—who are, so to speak, constantly surrounded with *fresh* (in contradistinction to putrid) blood—are singularly free from epidemics. We have also witnessed experiments, which if not conclusive are at least suggestive. Organic solutions and infusions were placed in U-tubes through which air was drawn by means of a Sprengel pump. Before flowing into one of these tubes the air had to pass

over a number of fragments of pumice slightly soaked in blood, whilst in the other cases it was passed over pumice similarly soaked in gum-water, solution of sugar, and other adhesive liquids. In almost every case the organic solutions which had received their air over blood were much slower in showing signs of putrefaction than were the others. Our friend contends that fresh blood has a positive attraction for morbific germs independent of its glutinous character. Experimentation during some outbreak of pestilence is here wanting, and in the meantime we suspend judgment.

We next come to the distinction between clean and unclean beasts as affecting the choice of food. We find excluded all carnivorous animals (Leviticus, xi., 27), the rodents (*ibid.*, 5, 6, and 29), the carnivorous and carrion-eating birds (*ibid.*, 13 to 19), reptiles (*ibid.*, 30), amphibia, and mollusca (12). The question now arises whether these regulations are exclusively symbolical, or whether they have not at the same time a sanitary meaning. If we consider what animals are thus excluded we can scarcely avoid entertaining the latter view. We find on the prohibited list, in addition to the swine—that eminently unclean beast—the mouse, and, *a fortiori*, the rat, and, as included among the carnivora, the cat and the dog. Here, then, we have in a group those beasts which are the home of *Trichinæ*, and through whose means, directly or indirectly, these parasites are introduced into the human system. Is this a mere unintentional coincidence, or have we have not rather wise intention? It may be said that, save the swine, none of the animals thus mentioned are used for human food. Such an assertion would be a great mistake. Dogs are eaten in China, in Poland, and from time to time, much nearer home, in the form of sausages. Cats enter into the Portuguese, and we suspect the Italian, *cuisine*. Rats and mice are eaten, not merely by Chinese and Gipsies, but find their way occasionally into soups, stews, and the like in Europe. Indeed, in "this our highly favoured country," a certain person, probably influential and evidently ignorant, wrote to a daily paper recommending rats as food for the poor, and adding the humane suggestion that any man who complained of starvation whilst rats were plentiful should be punished! We will charitably hope that the writer was not aware that rats are foci of trichinæ, and are with good reason suspected of being one of the sources from which these pests find their way into cats, swine, and certain fishes, such as the pike. The domestic cat and all the feline group are frequently and seriously infested with internal parasites.

The prohibition of mollusca,—or, as they are familiarly called, shell-fish, and as we should interpret the passages in question, of crustaceans, such as the crab, lobster, and shrimp—may perhaps be considered needless. But not a few shell-fish, such as the common muscle and even the oyster, are at times capriciously unwholesome and even poisonous. The crustacea are not merely notoriously foul feeders—the shrimp being sometimes spoken of as the "scavenger of ocean"—but their flesh is decidedly hard to digest. The snail is specially prohibited by name. Certain species of this animal are eaten in modern Europe and rank as a delicacy. But as they devour herbs poisonous to man, and feed greedily upon carrion and upon human excrement, their use as food is something more than questionable. It has been contended in reply that an animal which nourishes itself on poisonous or loathsome matter is not necessarily on that account poisonous or loathsome. There is some force in this remark in the case of a large animal, where the stomach and intestinal canal, with their undigested or half-digested contents can easily be removed before the body is eaten. But in such small creatures as snails and shrimps such an operation could not be performed without a degree of anatomical skill and an outlay of time not to be expected from the ordinary run of cooks. Besides, it is too much to assume that an animal feeding on foul, morbid, and unwholesome matter may be in itself wholesome. The flavour and the odour of animal food, meat, milk, butter, &c., are most perceptibly affected by the diet of the beast from which they are obtained, and there is hence a strong probability that the flesh of a poison- or carrion-feeder will be more or less unwholesome.

The hare is included among the prohibited species. Unlike many of its fellow rodents, it is not carnivorous, but it eats many vegetable poisons, such as the bark of the mezereon. It would be very interesting to ascertain in what animals, after death, the volatile organic poisons now known as ptomaines are most readily developed? It is possible that in this respect a difference might be found in favour of the "clean" beasts and birds of the Mosaic law.

As far, therefore, as food is concerned, we see in some instances very sufficient physiological reasons for certain of the prohibitions, and we have grounds for suspecting at least that in other cases these regulations may be equally well-founded. Certain it is that the Jews by the avoidance of blood, of the flesh of unclean beasts, &c., have reached a standard of health higher than that of the Gentile nations

among whom they sojourn. Shall we therefore justly incur ridicule if we pronounce these enactments wise?

From food we proceed to the surrounding of human habitations. Not only in the East under its modern rulers, whether Islamite or Christian, not only in mediæval Europe, but down to a comparatively late date, the streets of cities and villages were the common receptacle of filth and refuse of all kinds, stray dogs being the only scavengers. Dead domestic animals, excrements, spoiled food, bones, the rinds of vegetables, and every other noisome and unseemly by-product of human existence and activity were allowed to accumulate in every corner. But why speak of streets? The interior of our houses, and even palaces and churches, three hundred years ago must have been perfectly loathsome to anyone—could such have been present—accustomed to cleanliness. How strange it is, then, to go back for more than three thousand years, and find in the laws of Moses directions that all unclean matter shall be cast into a waste place outside the city! The removal of nuisances was further made imperative by the command that if any person touched carrion or excrement he should be "unclean till the even." We can easily see that no Jew would be willing to tolerate any preventible nuisance in or near his dwelling.

We have, lastly, regulations on the subject of personal cleanliness. It is a sad fact that not merely mediæval but modern Europe constrasts most sadly in this respect with the principal nations of antiquity. One of the most striking features in the law of Moses is the number and variety of circumstances under which washing is required. Again and again we read—"He shall bathe his flesh in water." It may safely be said that in the ancient Israelitish community few persons would be able to pass a week without an entire washing. It may as safely be said that till very lately numbers of persons in modern Europe passed entire years without washing any part save the hands and a circuit of six inches radius from the tip of the nose. So peculiar is human progress that it has taken three thousand years to bring the civilised world to a point less advanced than that occupied by Moses. Less advanced we say emphatically, because if we now admit the value of personal cleanliness, the importance of avoiding putrescent and loathsome matters, and of expelling them rapidly from our cities, and if we are theoretically aware of the disinfecting and deodorising power of earth, we are far from embodying this our knowledge in the practice of actual life. As to the avoidance of blood, of the flesh of foul-feeding animals, and of such as are liable to

introduce Entozoa into our systems, we do not even recognise verbally the importance of the Mosaic teachings. We eat "blood puddings," we feed swine with blood and with semi-putrid offal, and then we eat the animals which have been gorged on this revolting diet. And we pay the price of this uncleanness in shortened lives and in waning vigour. We again call attention to the remarkable physiological insight displayed in the sanitary code of the ancient Israelites, and we repeat the question, Whence did it spring?

VI. THE DESTRUCTION OF NOISOME INSECTS.

By J. W. Slater.

In the September number of the "Journal of Science" (p. 437) I referred to the fly-fungus (*Empusa muscæ*) as a possible agent for the extirpation, or at least reduction, of insect intruders. Since those remarks I have had the opportunity of experimenting on the transfer of the fungus to other Dipterous species, and with but limited success. Having found three common flies which had perished of this affection in the usual manner, I carefully removed them from the window-panes on which they were fixed. On examination with a powerful lens their bodies appeared covered with a very luxuriant crop of the fungus. I placed them in a small vivarium, and turned in three blowflies, a *Stomoxys calcitrans*, and two common house-flies in a healthy condition. Some sugar was supplied as food for the colony, and placed in such a manner that the flies in visiting it might be liable to come in contact with the three dead specimens. All the prisoners came in frequent contact with the presumed source of infection. The blowflies especially walked over the dead, pushed them about, and touched them with the rostrum. In course of time the two live common flies became languid in their movements, took up their station upon the glass, and finally died in the usual manner, their bodies and the glass for some little distance being

covered with a well-characterised growth of *Empusa*. The *Stomoxys calcitrans* died about the same time, but with less distinctly marked symptoms. It did not become cemented to the glass, but was found on its back at the bottom of the compartment. Over its body there was a white fungoid growth, agreeing with that on the common flies, though much slighter. The blowflies, which had taken much more frequent liberties with the infectious specimens than any of their fellow-prisoners, showed not the slightest trace of the disease; they buzzed about vigorously whenever the sun shone, and died finally without any traces of *Empusa* upon their bodies.

I resolved upon a more decisive experiment. I found two more common flies which had just died of the disease, and catching two lively blowflies I applied the spores of the fungus to their bodies by means of a camel's-hair pencil, going over both the thorax and abdomen, and in particular the region about the spiracles. I then turned the blowflies into the same vivarium, and watched what might happen. To my surprise they manifested no symptom of the disease, and died after about a fortnight an apparently natural death.

Hence it appears that, at least under the circumstances of the above experiments, this disease is not communicable to the blowfly.

It may further be added that the infectiousness of *Empusa muscæ*, even among the common house-fly, is not very great. The specimens which we find dead of this affection never form any at all high percentage of the flies infesting our houses. If we consider how these insects are given to touch each other, as if in a sort of game, and how they crawl over those of their fellows who have fallen victims to the *Empusa*, we are led to wonder that the disease is not more widely spread. Whether it may be possible by any artificial cultivation to render this fungus more abundant and more easily transferred from one individual to another, it would be premature to decide.

I may here briefly notice some interesting results on the use of the *Pyrethrum* as an insecticide, an account of which in full is to be found in the "American Naturalist" for last month. The powder of this plant is not, as popularly imagined, a universal insecticide. It is indeed very doubtful if such a specific exists. But the *Pyrethrum* most unfortunately acts most intensely and certainly where its efficacy is least to be desired. All the Hymenoptera are said to succumb most readily. Now this order includes so very few

of man's enemies, and so many of his most valuable friends, that we might well pause before attempting any widespread application of *Pyrethrum* powder to our fields and gardens. Amongst the Hymenoptera are included not merely the honey-bee, but the various humble-bees, &c., which play so important a part in the fecundation of many flowers. Here, too, belong the ichneumon-wasps which so largely contribute to reduce the number of caterpillars. Hence any agent generally fatal to the Hymenoptera will require care and judgment in its application. If it is fatal to ants it may be of great value in checking the ravages of the leaf-cutting species, and of those which protect and even introduce Aphides and scale-insects.

On the other hand, we are told, as among the results of a course of experiments extending over three years, that *Pyrethrum* has no action upon the eggs of insects, or upon pupæ enclosed in hard cases. Many hairy caterpillars also remain unaffected.

Hence, though the plant can doubtless be grown to advantage in most sub-tropical countries, we must not expect too much from its application.

ANALYSES OF BOOKS.

Volcanoes: What they are and What they Teach. By John W. Judd, F.R.S., Professor of Geology in the Royal School of Mines. London: C. Kegan Paul and Co.

We have here a work intended both to teach and to unteach. The author begins by showing the erroneous nature of ordinary school manuals as regards this subject. A volcano is not necessarily a mountain, but rather a hole in the earth's crust. When mountains do exist at the centres of such phenomena, they are formed by the matter expelled by the underground forces,—a mere consequence, and not a cause of what is in process. The action of a volcano bears no relation to burning; the supposed smoke is watery vapour, and the imaginary "flames" are merely the glow of melting rocks reflected from the clouds. The nature of volcanic action the author thinks may be best studied not in the violent outbreaks of such volcanoes as Vesuvius or Etna, but in the continuous and gentler action of Stromboli. Here it may be seen that the conditions on which the volcanic phenomena depend are the existence of apertures leading down from the surface to the interior of the earth, the existence of strongly heated matter below the surface, and the presence of quantities of pent up water underground, which is converted into steam and occasions the explosive outbursts which continually recur. Sulphuretted hydrogen and sulphurous acid are, indeed, emitted in quantities along with the steam, but the notion that the combustion of sulphur is the source of the heat is without foundation. Between the regular and mild action of Stromboli and the most dreadful outbreaks of Vesuvius the difference is simply one of degree, and a series of intermediate stages may be traced out. The lightning which accompanies the more violent eruptions is due to the friction produced by the escape of steam under high pressure from narrow orifies.

The action of volcanoes teaches us some highly interesting lessons concerning the earth's interior. We find that here there must be deposited matter of much higher specific gravity than that which forms the surface of the planet. The specific gravity of the entire globe is calculated by astronomical methods as being five and a half times as great as that of an equal bulk of water, whilst the materials of the earth's crust range only from two and a third to three times the weight of water. From this consideration alone we are forced to the conclusion that the deeper regions of the earth must be of much greater density. This conclusion is supported by an examination of the matter

thrown up by volcanic action. Hence it becomes highly probable that the interior of the earth consists chiefly of metals in a free state. If this view is correct it points to a process by which our globe will be in the course of ages rendered incapable of maintaining life, as the oxygen of the air will be gradually absorbed by these vast masses of metal.

As regards the physical condition of the earth's interior, the author does not accept the hypothesis, once in great favour, that it consists of a mass of molten matter enclosed in a thin solid shell. Independent of the astronomical and physical arguments for the earth's rigidity, amongst others that founded upon the absence of subterranean tides, he contends that if volcanic products were supplied from one common reservoir in the interior of the earth, the lavas should exhibit a much greater similarity of composition than is actually the case. But he admits that none of the hypotheses concerning the earth's interior is free from objections, and that we are not yet able to come to a final decision.

As regards the internal heat of the globe and the causes of volcanic action, we have also much to learn. Prof. Judd admits the rise of temperature as we bore deeper into the globe, and he even suggests that at no distant time "we shall draw extensively upon these supplies of subterranean heat." But the increment of temperature is not uniform; it varies in different parts as 1 : 5, and in not a few borings it has been found that the rate of increase after a time becomes slower. Thus in the well of Sperenberg, near Berlin, the rate of increase is 1° F. for every 55 feet, during the first 1900 feet of descent, but for the next 2000 feet it diminished to 1° F. for every 62 feet. A similar fact was observed at the well of Grenelle, at Paris. These phenomena do not agree with the assumption that in descending we are approaching a great focus of heat.

On the other hand, in the Comstock Mine the rise of temperature becomes accelerated at depths below 2000 feet.

In abruptly concluding oure notice of this interesting work we may fairly pronounce it a most able and judicious production. The author carefully eschews rash theories, and knows how to suspend judgment where the necessary evidence is not forthcoming.

Proceedings of the Literary and Philosophical Society of Liverpool During the 69th Session, 1879-80. No. XXXIV. London: Longmans and Co. Liverpool: D. Marples and Co., Limited.

Of the papers selected by the Council a very considerable proportion fall outside our cognisance entirely. We may mention "The Place and Power of Criticism," by the President, Mr. E.

R. Russell, who, in a former paper ("Journal of Science," 1879, p. 372), took occasion to sneer at Science as "blind and groping physicism." We need, therefore, feel little surprise at finding him come forward as a champion of competitive examination, and pronouncing the "popular cry against cramming not very respectable."

Two of the papers, viz., that on "Money, Coin, and Currency," by J. A. Picton, and "Plan of a Self-Acting Method of Regulating the Stock of Gold for the Paper Currency," seem to us more suited for a chamber of commerce.

Concerning "Eirik the Red's Saga" and the "Life of Mr. Justice Story," we have nothing to say, and may make a very similar admission concerning a memoir entitled "On the Simplest Possible Experiment in Physical Science," especially as its author, the Rev. T. P. Kirkman, F.R.S., has at the conclusion criticised himself.

Mr. A. J. Mott, F.G.S., examines the "Nebular Theory," and points out some very grave objections to its truth. He suggests that "the heat radiated into space cannot be really lost, but must be retained as energy in some other form, possibly in the form of the cause of gravitation, to make the duration of a moving and living universe practically without limit, both in the future and in the past."

"Life in the Lowest Organisms" is the title of an interesting paper by the Rev. H. H. Higgins. The author remarks very justly that "no one has ever seen or known protoplasm, except as *the* protoplasm of some special form of living animal or plant." Speaking of *Protomyxa aurantiaca*, which Prof. Hæckel pronounces the lowest known living animal, he shows that it is capable of feeling hunger, and asks how is this sensation to be accounted for? "Here, where we cannot go back to preceding lines of evolution, where there is no hereditary chain that we know of, at the very base of the scale of life, hunger is exhibited." "No alternative seems to be left but to describe this habit of the creature (its encasing itself with grains of sand, &c.) as representing the first beginnings of that selective instinct by which . . . . untutored man himself sets up his hut or his wigwam." Mr. Higgins points out the beauty of the shell of the *Polycistina* as inexplicable on the mere principle of utility. Neither, he holds, was it developed only for man to admire. He shows that twelve of the most prominent characteristics of the world of life appear in the lowest form of living things, whilst lifeless matter is destitute of any of them. "In the present state of our knowledge the beginning of life must, it would seem, be held to be an exception to *ascertained* continuity in Nature as expressed by the theory of evolution." The author, if we remember rightly, has on former occasions used the term Evolution, not as including, but as in some respects opposed to, Darwinism. He remarks that "constitutional differences between specimens of the same

species in the lower classes of organisms form an almost unexplored field in Biology." The following reflection is suggestive:—"An imperfect adjustment between qualities good and indispensable in themselves may be the source of all the mischief commonly attributed to propensities radically evil." In this brief essay there is more of original, valuable thought than we often meet with in bulky volumes, and we earnestly commend it to the study of all biologists.

The preliminary report on specimens dredged up from the Gulf of Manaar, by H. J. Carter, F.R.S., points to important results in the future, both biological and geological. The author thinks that this little inlet contains an epitome of nearly all the marine organisms existing in the Indian Ocean. He thinks that as yet we have hardly entered upon the dawn of all the sponge life that exists on the surface of the globe.

The last memoir in the volume, and with one exception incomparably the most valuable, is by Rev. W. H. Dallinger, F.R.S., and is entitled "Life-Histories and their Lessons: A Defence of the Uniformity and Stability of Vital Processes as Controlled by the Laws of Evolution." In it he discusses and controverts the hypothesis of heterogenesis, which he shows to be by no means essential to the doctrine of Evolution.

Mr. C. D. Jones, C.E., of San Paolo, Brazil, communicates additional interesting matter on Lepidoptera of that region.

The examination of this volume has confirmed us in a notion which we have long entertained, that our "Literary and Philosophical Societies" ought to be submitted to a process of dissociation. Each of their elements would be better in a "free" state.

Journal and Proceedings of the Royal Society of New South Wales, 1880. Vol. XIV. Edited by A. LIVERSIDGE, Professor of Chemistry and Mineralogy in the University of Sydney. Sydney: Richards. London: Trübner and Co.

WE cannot profess to be wholly satisfied either with the present volume or with the condition of the Royal Society of New South Wales. We learn with regret that the Biological Section, along with several others, has not met during the year 1880. Among the papers read before the Society, Biology is merely represented y a "Catalogue of Plants Collected in North Western Australia." This circumstance is the more mortifying when we reflect how very much remains to be done in the zoology of Australia itself, and of the islands situate to the north east.

Nevertheless, there is much matter in this volume which must claim the careful attention of men of science.

We turn first to the "Anniversary Address," delivered by the Vice-President, Mr. C. Moore, F.L.S. The speaker referred to the dying off of various species of Eucalyptus in the Camden district. This affection occurs in belts, usually running north and south, the trees on either side remaining unaffected.

Mr. Moore next referred to the very curious contention raised by a Mr. W. E. Abbott, of Glengarry, that the destruction of forests does not affect the rain-fall, or cause the drying-up of rivers by increased evaporation! An assumption so flatly opposed not to "theories," but to positive observations made in almost every quarter of the globe, ought, we think, to have been advanced with much more reserve. If some unseen fallacy does not lurk in Mr. Abbott's statements, it will follow that Australia differs from the rest of the globe in its climatic conditions no less than in its fauna. It will be, we think, highly unwise if the Colonial governments allow the destruction of the forests to proceed—whether by "ring-barking" or any other method—without very much more evidence than has yet been produced.

Another remarkable feature in the Anniversary Address relates to insectivorous plants. Mr. Moore tells us he is "in the unhappy position of being unable to acquiesce in the doctrine that the plants termed insectivorous, or those that are said to derive their nourishment (? a part of their nourishment) from animal matter, were intended by nature to depend on or benefit by any such means for their support." He admits, of course, that certain plants catch insects, but denies the purposiveness of such capture.

Baron Mueller's catalogue of the plants of North-western Australia brings some interesting facts to light. Out of the 400 species collected by Mr. A. Forrest and Mr. J. Forrest during their surveying expeditions, there is not a single orchid. Mr. R. D. Fitz-Gerald has produced a valuable monograph, beautifully illustrated, of the Australian orchids. Mr. Bailey, F.L.S., of Brisbane, is working up the lower orders of the Australian flora.

A paper read before the Medical Section, by Dr. F. Norton Manning, is of grave importance. It is a very serious consideration that even in so young a community as Australia, free, as it might be thought, from many of the evils which affect over-crowded countries, the spread of insanity should excite the attention of far-seeing men, both within and without the profession. Intemperance, Dr. Manning shows from his experience at the Gladesville Asylum, is responsible for about 8 per cent of the cases. He agrees with Dr. Grabham, Dr. Bucknill, and other English physicians, in maintaining that the effects of drunkenness, in this direction, have been grossly exaggerated. He points out that even kerosene is used in the adulteration of alcoholic drinks. As remedial measures, he suggests a reduction in the number of taverns, the introduction of sound light wines—which in Australia might certainly become the common drink of all

classes—and the general use of ice. In this last point we cannot agree with him; the habitual use of ice and iced water in America, in the hot weather, is recognised as a fruitful cause of congestion of the brain.

In connection with sun-stroke the author mentions that 5 per cent of the cases of insanity in Australia are due to this affection. He states that a thermometer graduated up to 234° F., and exposed to the sun with its bulb wrapped in black cotton-wool has been known to burst. Hence he justly denounces the "black stove-pipe hat," to which Englishmen and their colonial descendants cling with a pitiable fanaticism.

He fully admits the hereditary transmission and multiplication of insanity, and hopes that in a more enlightened future when the whims of the individual are subordinated to the good of the community "it will be found expedient in the interest of future generations to insist on prolonged isolation or operative interference in the case of all persons who have been afflicted with mental disease." Joining Dr. Manning in the wish, we cannot help fearing that we are drifting in the very opposite direction.

On the influence of consanguineous marriages in occasioning degeneracy, and in particular insanity, the author speaks with some reserve. He remarks, however: "In the few cases in which two imbecile children in one family have come under my observation, the parents have always been nearly related, and in the only instance in which I have known three children in one family idiotic, I obtained evidence that they were the offspring of the incestuous union of brother and sister." He also quotes Dr. Mitchell, one of the Commissioners of Lunacy for Scotland, who ascribes 10 per cent of the idiocy of Scotland to consanguineous marriages.

The author's opinions on the worry, haste, and competition of modern civilisation as factors in racial decay, and especially in the spread of insanity, we most cordially endorse. He denounces "our present system of stuffing our youth and making all boyhood and girlhood one long period of cramming for examinations. . . . . The whole system tends to confuse and distract the mind, to unfit it for the work of the world, to stunt originality, and to induce what has not inaptly been termed 'brain-fog.' Where there is no breakdown at the time—and instances of this are much more frequent than is commonly supposed—seeds are planted for the growth of mental disorder later in life. I know no stronger evidence as to the evil done by overwork in schools and competitive examinations than that of Dr. Andrew Clarke, who states that he has discovered temporary albuminuria in 10 per cent of the candidates sent him for examination as to physical health after passing the Civil Service examination for India."

Who that has sufficient medical knowledge to comprehend this one fact will not execrate the "Playfair scheme?"

Annals of Chemical Medicine, including the Application of Chemistry to Physiology, Pathology, Therapeutics, Pharmacy, Toxicology, aud Hygiène. Vol. II. Edited by J. L. W. Thudichum, M.D. London : Longmans and Co.

Here, as in the former volume of the work, we find an assortment of memoirs, which, in their thoroughness, and freedom from unwarranted assumptions, are deserving of recognition and imitation.

One of the most interesting of these papers is entitled "Anæsthesia by Volatile Alkaloids, as illustrated by Opium Smoking." Here, the author not merely shows the value of this much-denounced practice in pulmonary consumption, especially when attended with diarrhœa and blood-spitting, in bronchitis, neuralgia, pneumonia, carbuncle, &c., but exposes the sensational statements indulged in by the "Friend of China." It is certainly strange, if, as is sometimes said, we "force" opium upon the Chinese, a large and increasing quantity of this drug—not less than five million lbs. yearly—is grown in China itself!

A paper on "The Fate of Morphia in the Body" is also important. Even if injected into the subcutaneous tissues it is soon decomposed after it finds its way into the blood. This fact is the more significant because the attempt was made, not very many years ago, to define poisons as bodies which, if introduced into the system, remained in it for a time unchanged, and were finally, if not taken in fatal doses, eliminated as such. Now, as morphia is an admitted poison, the definition which, we believe, was originally proposed by the "physiologists of temperance," falls to the ground.

In a memoir on the "Sources of Urea in the Body," Dr. Thudichum considers that there are many and weighty physiological objections to the hypothesis that all albuminous matters in the course of biolysis in the body are split up in the same manner as by chemolytic means out of the body.

The paper "On the Decrease of Hæmochrome in the Blood in Diseases and under Insalubrious Influences" is a valuable summary.

A memoir on the "Phosphorescence of Organic and Organised Bodies" contains many facts which must be borne in mind by those who are inquiring further into the distribution and the significance of this phenomenon in the organic world. It would appear that the phosphorescence of living beings is attended with an increased consumption of carbon, and therefore, of necessity, with increased heat. Fabre observed that the fungus *Agaricus olearius* gives off much more carbonic acid when phosphorescent than when dark. Almost all observers agree that both for plants and animals the presence of oxygen is necessary for the manifestation of phosphorescence. Panceri, Secchi, and

Phipson maintained the mono-chromatic character of the light of marine animals, but Secchi, on repeating his observations with more perfect instruments, found that the light of *Lampyris* and *Pyrosoma* yielded a continuous spectrum, the red and violet parts being, however, very feeble. It is here stated that the phosphorescence does not seem to be under the control of the will of the animal. Certain observations made upon insects do not agree with this view, as they appear able to emit their light at short rhythmical intervals, or to suppress it altogether if alarmed. The subject is by no means thoroughly understood.

The Popular Science Monthly. September, 1881.

In this ably-conducted journal there are some articles demanding especial notice.

Dr. F. L. Oswald continues his valuable papers on Physical Education. He tells us, however, somewhat strangely that "the young of other creatures (than man) are healthier than the adults." We strongly doubt the accuracy of this statement. Many species, both animal and vegetable, are difficult to rear, though healthy and vigorous enough when once the stage of infancy is past. He denounces "Sauerkraut," and has evidently no sympathy with cod-liver oil.

An article on the "Increase and Movement of the Coloured (more correctly Negro and Negroid) Population," by J. Stahl Patterson, presents certain conclusions of grave import to the whole civilised world. According to the results of the last census the negro population of the States is increasing more rapidly than the Aryan part of the community in the ratio of 34·8 to 29·2. This result shows that the assumed tendency of the lower races to die out in presence of the superior does not hold good. The writer shows that if the rates of increase registered during the last decade are continued, in another century the United States will be not an Anglo-Saxon, but mainly a negro republic. *Absit omen!* Incidentally he contends that the possession of high culture is a surer check on population than the "positive checks" of Malthus. This is, indeed, the fatal flaw of Malthusianism. Unless it could be forced upon the lower races, and upon the criminal, debilitated and idiotic portions of the higher, it must lead to the ultimate suppression of the *élite* of mankind.

In an article on the "Progress of Higher Science Teaching," by W. H. Stone, borrowed from the "Popular Science Review," the writer seems to overlook the fact that the old system of education erred by fixing the attention of the pupil upon words instead of things, and thus failing to train him up in the art of observation. Now, Science, if righly taught, makes the pupil an observer.

Proceedings of the Literary and Philosophical Society of Liverpool during the Sixty-eighth Session, 1878-79. No. XXXIII. London: Longmans and Co. Liverpool: D. Marples and Co. (Limited).

This volume contains some very valuable matter. Dr. J. J. Drysdale contributes a very elaborate memoir on the "Germ Theories of Infectious Diseases." He warns us that we have no warrant for supposing that the days of epidemics are over. "The immunity of any generation from the greater plagues may be merely an interruption of the course liable to terminate any year by a fresh outbreak of some old or a quite new plague." Following Liebermeister, he divides the diseases in question into three classes:—the truly contagious, where the *materies morbi* is reproduced in the organism suffering from disease, such as small-pox, plague, typhus, &c.; the miasmatic, such as the remittent and intermittent marsh-fevers, where the poison is developed externally to the body; and lastly, the miasmatic contagious diseases, such as cholera, dysentery, and typhoid, where the secretions of the infected persons undergo a further development out of the body. On the exact nature of infectious matter it may be at any rate regarded as ascertained that the specific power does not reside in anything gaseous, liquid, soluble, or diffusible, but in particulate matter. Such matter will either be an organised ferment, a parasite, or a portion of living matter capable of transplantation and growth in the bodies of other persons. The inference, however, that the growth and development of parasitic microphytes in the blood is the cause of specific diseases in general, Dr. Drysdale considers as somewhat hasty. He maintains that "one of the chief aims of medicine should now be to turn these fearful engines of power (infectious diseases) into agents of protection against and cure of the very evils produced by their uncontrolled natural operation." The memoir is deserving of very careful perusal, and of a much more thorough investigation than space allows us to give.

The Rev. H. H. Higgins undertakes to give an answer in the negative to the question "Is Nature cruel?" By cruelty he understands that which is exhibited in the infliction of needless and profitless pain." In examining the argument it may be sufficient to turn to the learned author's defence of the mosquito as a sanitary agent. Admitting for argument's sake,—and it is an enormous admission,—that the tundras of Siberia and the plains of the far north-west of America would suffer from malarial fever were it not for the operations of the larvæ of mosquitoes, overlooking the fact—referred to by Dr. Drysdale in the memoir just referred to—that these insects are the conveyers of disease from person to person, we point to the circumstance hat millions upon millions of them live and die without ever

tasting human or indeed any kind of mammalian blood. Hence it follows that such blood is not necessary to their existence, and that the pain which they inflict is as "needless" as "profitless."

Mr. A. E. Nevins is the author of a paper on "Modern Meteorology, considered in its Bearing upon Tropical Storms." He argues that in whatever part of a storm a ship is, she will be approaching the centre, in a more or less oblique direction, if she runs dead before the wind. He raises the question whether the two currents of air forming such storms are not charged with electricity of opposite names?

J. Linton Palmer furnishes some interesting notes on the "Colours of the Sea."

The Rev. T. P. Kirkman, F.R.S., writes on the "Solution of the Problem of the Autopolar *P* Edra with Full Construction up to $P=10$." He remarks, "It may come to be evident, although I confess that I cannot clearly conceive how, that this complete theory of the polyedra is a necessary introduction to dynamical science yet undiscovered." He adds, "For look how grandly we can talk about matter and law—this Realm of Matter and this Reign of Law! or, more accurately, this Realm of Rubbish and this Majesty of Must-be."

Richmond Leigh, M.R.C.S., treats very ably on "Changes of Climate, Secular and caused by Human Agency." He expounds in particular the dire mischief which has been occasioned by the wanton aud reckless destruction of forests.

Dr. Francis Imlach contributes a memoir on the "Levantine Plague, Past and Present," and warns us to be wise in time.

Mr. F. P. Marrat, in a paper on the "Arrangement of the Shells in the Genus *Nassa*," remarks that fully nine-tenths of the shells now ranking as species will be found to come under this general term (*viz.*, intermediate forms, and even many of those at present appearing as distinct will find a place in this series.

Mr. E. D. Jones, of San Paolo, Brazil, communicates some very valuable notes on the larvæ and pupæ of Brazilian Lepidoptera. The larva of a *Papilio* (species not named) is described as having the power of flinging a drop of a fluid (colourless, but possessing a very pungent and offensive odour) upon the offending object. The author is doing exceedingly useful work in studying and recording the metamorphoses of the Brazilian butterflies.

At one of the meetings of the Society Mr. Jos. Boult argued that overcrowding is by no means so important an element in the causes of a high death-rate as is generally supposed.

Spon's Encyclopædia of the Industrial Arts, Manufactures, and Commercial Products. Division IV. Edited by C. G. Warnford Lock. London and New York: E. and F. N. Spon.

This part of Messrs. Spon's work shows no falling off in the value of its contents. In the article on Ivory we note some interesting facts on the growth of the tusks, not only in the two species of elephant, the Indian and African, but in different breeds in each country. Thus the tusks from Bengal rarely exceed 72 lbs., and those of Tipperah 50 lbs., whilst tusks from Pegu and Cochin reach a weight of 150 lbs. Turning to the African species, we find Zanzibar tusks averaging 122 lbs., and at times ranging up to 227 to 280 lbs. Tusks from Angola, on the other hand, do not average more than 69 lbs. Hence the size of the tusks cannot be accepted as a decisive point in the diagnosis of species.

The article on "Mordants" compresses into brief space a wonderful amount of practical information, and is evidently the work of some writer thoroughly acquainted with his subject, and not of one who has "read up" for the occasion.

The chapter on "Narcotics" is exceedingly instructive. The following passage on opium will perhaps surprise some of our philanthropists:—"With regard to its use as a narcotic great efforts have been made by a few well-intentioned, but ignorant, people to procure its annihilation. But though the abuse of the drug leads to evil consequences,—by no means equalling, however, those of the abuse of alcohol in this country,—its moderate use is extremely beneficial, if not absolutely necessary, in the malarial climate of China; and the immunity of opium-smokers from diseases of the bronchial tubes and lungs, so common among non-smokers, is remarkable." The production of opium in China itself is increasing, despite paper-prohibitions, and already supplies 5,000,000 lbs. out of a total yearly consumption of 17,000,000. Persia likewise exports to China an increasing supply of opium which successfully competes with the Indian growth. Hence it appears highly probable that if our philanthropists would abstain from the luxury of agitation, they might see the Indian opium-trade gradually dwindle away.

It is a remarkable fact that the strongest samples of opium have been produced in France, where percentages of 20 to nearly 23 per cent of morphia have been reached. The maximum proportion in Smyrna opium is 21·46 per cent, whilst the highest point reached in India (Patna) has been 8·6 per cent. It is worthy of note that in countries where legislative attempts have been made to abolish the consumption of alcoholic liquids, the use of opium and its preparations is decidedly on the increase.

It is strange and not pleasant to learn that 230 poods of the

poisonous Siberian toadstool (*Amanita muscaria*) have been imported into England in one year. Such a quantity can scarcely have been consumed in medicine or in chemical research, and we therefore fear that it is employed among us as an intoxicant.

The article on "Nuts" will be found very suggestive by all who are interested—and what far-seeing man is not?—in the growth of our colonial resources. It is stated that in India the coco-nut trees are often damaged by a Curculio (*Calandra Berquetii* or *palmarum ?*) which the writer terms an "elephant-beetle"—a misleading name. This pest "reappears at intervals of two, three, or more years." These periods ought to be more closely observed.

The chapter on "Oils," including as it does the saponifiable, the essential, and the mineral oils, is the most extensive and elaborate in the whole volume. We have often been struck with the feasibility of introducing palm oil into this country in such a state as to supersede "butterine" and its kindred mixtures. All that is necessary, we believe, is to add to the oil a trace of salicylic acid to prevent rancidity. Non-rancid palm oil is exceedingly pleasant in flavour, and would possess the advantage of entire freedom from the ova of Entozoa, and other abominations which have often been traced in butterine.

We are thoroughly satisfied of the value of "Spon's Encyclopædia" for merchants, manufacturers, &c., who will here be able to lay their fingers upon information which they might otherwise seek for in vain.

Monthly Notices of Papers, and Proceedings and Report of the Royal Society of Tasmania for 1879.

The Tasmanian Society has been doing no small amount of useful work.

A. B. Crowther, M.R.C.S., communicates a paper on some points of interest connected with the Platypus. Every point in the reproduction of this animal, except the actual birth of the young, has now been elucidated, and the supposition of its oviparous character is now completely abandoned. A curious feature is that the mammary glands of the female appear and disappear with great rapidity. Two or three months before the birth of the young not even a rudiment of the gland can be discovered, and it as completely disappears when no longer needed. The poisonous character of the secretion ejected through the hollow spurs on the right legs of the males is fully proved. It is employed by them when fighting for the possession of the female. About the breeding-season specimens are often caught with

patches of ulceration on their skins resulting from poisoned wounds.

Baron F. Von Mueller supplies a "Census of the Plants of Tasmania," up to 1879.

Mr. Justice Dobson and A. Simson both contribute papers on the codlin moth (*Carpocapsa pomonella*), a depredator which is committing serious mischief in the apple and plum orchards of the colony.

R. M. Johnston gives a memoir on the "Natural History of the Marine Tertiaries of Table Cape," with a description of thirty new species of Mollusca; and notes on the "Distribution and Variability of Tasmanian Land Shells."

The Right Rev. Bishop Bromby, D.D., read a paper on the "Law of Storms," with especial reference to the Southern Hemisphere. He considers that in the Tasmanian waters a storm generally arises from a conflict between an easterly and a westerly wind, the easterly always flowing on the polar side of the westerly.

We are happy to find that there are in Tasmania persevering and able observers who turn their attention to local phenomena,

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The Microscope and its Revelations. By W. B. Carpenter, C.B., M.D., LL.D., F.R.S., &c. Sixth Edition. Pp. 882, 26 Plates, 500 Wood Engravings. London: J. and A. Churchill. 1881.

It is pleasing to see another edition of this well-known handbook. Our veteran microscopist has undertaken the work with his old vigour undiminished; keen both in sight and intellect. No new discovery has escaped him, and the book faithfully represents the state of microscopical science up to the time of going to press.

The title naturally suggests the plan of the work; this, indeed, has been but little changed through the whole of the six editions, save in the alteration caused by scientific progress, and the extension of some important subjects. To the instrument itself four chapters are devoted, the first containing a plain account of the optical principles of the microscope, the remaining ones containing a description of the various kinds of microscopes made both in England and abroad, and the various accessory apparatus employed. The mode of using the microscope is described at great length. The notes on errors of interpretation are very important, and include the new discoveries of Professor Abbe on diffraction spectra. The value of these cannot be overrated, and Dr. Carpenter has done well to give great prominence to the

subject, for, although already published, it is still unknown to many microscopists, and little heeded by many more.

The chapter on mounting and preparing objects includes all the most recent processes in the time that has elapsed between the publication of the present and the former edition. The improved processes of section cuttings, aided by the use of reagents for staining, hardening, corroding, and in other ways rendering obscure structures more readily visible, have quite revolutionised this department of microscopical science. The student will find here an account of nearly all the best processes in use, and references to many others not included in the book. This chapter concludes with some valuable hints on collecting. The author's experience in the "Porcupine" and "Challenger" expeditions renders him a reliable guide on all matter relative to marine collecting.

The remaining two-thirds of the work is occupied, as of old, with an account of the minute structure of the vegetable and animal kingdoms. In some departments—for instance, the Foraminifera—Dr. Carpenter is probably the greatest living authority. The result of his researches on *Eozoon* are given at some length. The descriptions throughout are interspersed with the mode of carrying on the needful observations where necessary to supplement the instructions given in the earlier portion of the book. These notes in special modes of observations are of great value, as microscopists, in describing the results of their observation, too often take it for granted that the means by which these results are attained are known to everyone, while, as is often the case, special apparatus or treatment has been necessary to ascertain some most important fact.

On the vexed question of aperture of object-glasses Dr. Carpenter expresses a very decided opinion. While admitting the value of well-corrected objectives of the large apertures recently attained, for a certain set of purposes, he cannot endorse the statement of some enthusiasts, that with such excessive apertures alone can structure be truly made out. Evidence is certainly in Dr. Carpenter's favour; for some of the most important discoveries of modern times have been made with objectives of high power and comparatively small aperture, and the value of an amount of great depth, not to be had in combination with very great aperture, has often to be considered.

It is to be regretted that, in this and one or two preceding editions, space could not be found for the introductory chapter which formed so interesting a commencement to some of the earlier editions.

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

HAILSTORMS.

To the Editor of the Journal of Science.

Sir,—I am preparing a memoir for the Meteorological Society, on "Hailstorms." Might I ask you to assist me by requesting any of your readers who have opportunities of observing hailstorms to furnish me with particulars of them? The points to be particularly observed are as follow:—

1. *Date*, and hour of the day.
2. *Area of the Storm.* If it assume the tornado form, give (*a*) length of the course, (*b*) breadth, (*c*) direction of motion, (*d*) rate of progression.
3. *Physical Features* of the locality: (*a*) elevation, (*b*) mountains and plateaux, (*c*) rivers and valleys, (*d*) forests, &c.
4. *Temperature:* (*a*) before the storm, (*b*) after the storm, and, if possible to be observed, (*c*) changes during the storm.
5. *Barometrical Readings*, frequently taken during time of hailstorm.
6. *Wind:* (*a*) direction near the earth's surface, (*b*) direction in the higher regions as indicated by the cloud-motions, (*c*) force.
7. *Preceded or followed by Rain.*
8. *Aspect of the Clouds.* Note if there is any appearance of two separate strata at different elevations.
9. *Electrical Phenomena.* Should there be lightning, note the relation between the discharges and the fall of the hail—whether the lightning precede the hail, or *vice versâ.*
10. *Duration* of the storm at one spot.
11. *Sound.* Note if a peculiar noise precede the descent of the hail.

12. *Conformation and Size of the Hailstones.*
13. General character of the weather before and after the storm.

I should also be glad to receive references to previous memoirs on hail, or accounts of storms.

You will much oblige by giving publicity to this.—I am, &c.,

F. A. B. Oliver.

Athenæum, Glasgow, July 26, 1881.

AËRIAL NAVIGATION.

To the Editor of The Journal of Science.

Sir,—I venture to trespass still further on your forbearance, in continuation of my letter on "Aërial Navigation," in your issue for August.

I cannot deny that I fear there may be such horrors as you hint at, as the concomitants of the immediate *beneficial* results of the practical solution of this problem. So long as men's minds are blind to the full blessings of progress, the "ape and tiger" lurking in most of us will come into view on suitable opportunities. Let us hope, however, that the development of communications will ever tend to exercise its educating and humanising power over "the ruder, less civilised portions of the globe;" though whether the more civilised and more enlightened nations will awake to the conviction of the *worse than waste* of war, without a rude shock, it is vain to foretell.

But must the car of progress be stopped because some infatuated spectators may make it a car of Jaganát to their fellows and themselves, and because the world may abuse the mental, moral, and material gifts it brings? Must (*e.g.*) chemistry cease to add to the wealth and comfort of man, because desperate or dastardly individuals use some of its discoveries to further their own unprincipled ends?

The war fiend appropriates to its own devilish ends the triumphs of Steam and Electricity. Must these be therefore discredited, and because their power for good may be largely discounted by their power for evil? Must, then, progress be delayed until man is fit to receive its fruits; or should we (like Victor Hugo) "believe in all kinds of progress," and endeavour to educate man to refrain from abusing his new wealth? Should we not hope that thus, and that soon, "the common sense of

most" will be able to hold such "fretful realm in awe," and that "the kindly earth shall slumber, lapt in universal law"?

* * * *

"Science moves but slowly, slowly,
Creeping on from point to point."

Should we then endeavour to make it move *more* slowly because we dread the power it may give to the unscrupulous? I think not.—I am, &c.,

AËRONON.

THE SMELL OF THE INSANE.

To the Editor of the Journal of Science.

SIR,—Although you ridiculed Dr. Richardson's opinion that the insane have a peculiar smell, perhaps the subject may be worthy of inquiry. I have been assured, by one who had means of observing, that nearly all the insane have a peculiar odour, which varies much in different patients, but which my informant thinks can be generally distinguished from other personal odours. May not disorders of the brain be associated with disorders of the excretions? —I am, &c.,

B.

[We think our correspondent will find, on re-examination, that our ridicule extended merely to the sensational language employed by Dr. Richardson.—ED. J. S.]

CUCKOOS.

To the Editor of the Journal of Science.

SIR,—A peasant assures me that he can tell the foster-parents of young cuckoos by their baldness. He says that the feathers of the head are worn off by the cuckoo when fed taking it into its gape.—I am, &c.,

HUGH BROWNE.

VOCAL SOUNDS.

To the Editor of the Journal of Science.

SIR,—Your last volume notices Faber's speaking-machine as uttering fourteen distinct vocal sounds, and combining them into any words in any language. The elemental sounds of English are usually reckoned at about forty. Better analysis reduces these elements of speech, just as it has reduced the elements of chemistry; *e.g.*, the elementary vowels are six, namely, *e*, *a*, *ah*, *au*, *o*, *oo*. I believe an harmonic octave *e* makes the difference between *p* and *b*, *t* and *d*, *k* and *g*, *f* and *v*, *sh* and *zh*, *s* and *z*, *th* in thigh, and *th* in thy; and this lower octave may be the "drone" of which you speak, and which is itself an element. Then come *l*, *r*, *m*, *n*, and *ng*, making, I think, ten elemental sounds in English. Then we must reckon the German *ch* (which survives in Scotland), the French *u*, and I think there is a sound peculiar to Polish, and other tongues supply other elements, How are these pronounced by a machine speaking only fourteen elements?—I am, &c.,

HUGH BROWNE.

Nottingham, August 28, 1881.

NOTES.

M. LEDOULÆ has forwarded to the Geographical Society valuable information concerning the tzétzé fly, of which a notice has already appeared in "L'Union Médicale." All travellers in equatorial Africa have had good reason to notice the destructive power of this insect, the sting of which is death to oxen, horses, asses, camels, and even to dogs. Dr. Kirk, British Consul at Zanzibar, has, at the present moment, a work in preparation on the tzétzé fly, which he considers to be one of the greatest obstacles to the civilisation of Africa. A curious fact has been noticed in the post-mortem examination of animals which have died from the effects of the tzétzé fly's sting—namely, that there is no lesion whatever of the spleen, liver, lungs, or brain. The symptoms causing death resemble those of glanders. It is supposed that this disease is infectious to animals of the same species.—*Medical Press and Circular.*

Speaking of the twenty-eighth Annual Report of the "Science and Art Department," the "Standard" happily says—"It is quite as bulky, as intensely official, and if possible more self-complacent than ordinary."

It is an error to assert that the fly now committing depredations in the olive-grounds of Southern France (*Dacus oleæ*) is a species not hitherto observed. It was mentioned forty years ago under the same name, by Prof. Westwood, in his "Modern Classification of Insects."

Prof. Huxley, in a Lecture delivered before the Medical Congress, asserts that "The essence of modern, as contrasted with ancient physiological science, appears to lie in its antagonism to animistic hypotheses and animistic phraseology."

Miss F. P. Cobbe has been throwing some more "broken light" upon vivisection, before an audience of lady dog-fanciers and sentimentalists at Edinburgh. Mr. D. McLaren followed in a similarly illogical strain.

We have this season fully confirmed the statement that the tomato plant is avoided by earwigs, caterpillars, aphides, the cuckoo-spit insect (*Aphrophora spumaria*), and even by slugs and snails. But it does not appear to have any protective influence upon other plants in its immediate neighbourhood.

M. H. Toussaint ("Comptes Rendus") has experimentally established the parasitical character of tuberculosis. He has

collected the microbia of the disease, and cultivated them artificially.

According to "Les Mondes," a manuscript work of Copernicus has been discovered in the Observatory of Stockholm. It was formerly the property of Helvetius.

M. C. K. Hoffmann ("Archives Néerlandaises," xvi., 2), in a memoir on the development of the *Plagiostomi*, notes the formation of the dorsal chord from behind forwards, in the cartilaginous fishes, as of importance from a phylogenetic point of view. This is in accordance with the fact that the anal aperture of Rusconi (aperture of invagination, or *Urmund*) originally marks the anterior extremity of the animal.

According to the official Mineral Statistics of Victoria, the yield of gold for 1880 exceeds that for 1879 by 70,173 ounces. The total yield of silver for the year is 23,248 ounces.

Crioceris asparagi is committing serious ravages on asparagus in France. Aniline hydrochlorate dissolved in water, in the proportion of 500 grms. per hectolitre, is used as a remedy.

Dr. C. Callaway, writing in the "Geological Magazine," considers the organic nature of *Eozoon Canadense* not proven.

Mr. W. Williams ("Geological Magazine") finds no evidence that the Irish elk, *Megaceros Hibernicus*, was extirpated by, or was even contemporary with, man. In no instance has it been found in the peat.

MM. D. Verbrek and R. Fennema ("Archives Néerlandaises") have examined the pre-tertiary deposits of Java, and report that in this island there occur many tertiary deposits and few ancient strata, whilst in Sumatra, and especially in the highlands of Padang, the reverse is the case.

Von Baumhauer ("Archives Néerlandaises") finds that true diamond, bort and carbon, differ respectively merely by a more or less perfect crystallisation, and pass into each other by insensible degrees.

MM. J. Künckel and J. Gazagnaire have studied the seat of taste in the Diptera, and sum up their results in a paper laid before the Academy of Sciences, to the effect that the seat of taste commences in the paraglossæ, is continued along the false tracheæ, is manifested more strongly at the extremity of the epipharynx, where there occurs a bunch of nerve-terminations, and comes to an end at the entrance of the pharynx.

In the "Revue Internationale des Sciences Biologiques" the Museum of Natural History at Paris is said to be dying of senile despotism and shameless nepotism.

A large zoological station is being constructed in the Parc des Princes, at Passy, near Paris.

The temperature in Norway during the last winter, from October, 1880, to March, 1881, has been 7° C. lower than the average. At Karasjok the lowest temperature registered, between January 13th and 18th, was −50·6° C.—a greater degree of cold than has ever been observed there before.

At Prague the thermometer descended to −15° C. in the first week of June, destroying numbers of swallows.

Dr. Sacc, of Montevideo, contends that rabies in dogs might be entirely prevented by increasing the number of females and decreasing that of the males.

According to M. C. Maze, on June 27th the temperature at Memel (22·9° C.) was the same as at Algiers, 19° farther south; and on the same day the thermometer stood higher by 5·4° at Ulleaborg, at the head of the Gulf of Bothnia, than at Paris.

L. Hervé (" Les Mondes ") thinks that all species of animals, man included, are larger and more vigorous on calcareous than on siliceous soils.

The " Medical Press and Circular " considers that up to the present time " sanitation " has had no apparent effect in reducing the prevalence of certain diseases, more especially diarrhœa, diphtheria, and fever of typhoid type: the recent epidemic of smallpox further shows that the virulence of that disease has undergone no diminution whatever.

It is not generally known that the sense of smell may be made, for the time being, more acute by filling the mouth with very cold water.

According to Captain Vassel, the Nile, in the Diluvial epoch, discharged itself into the sea in the midst of what is now the Isthmus of Suez, gradually filling up the narrow and shallow strait which then connected the Red Sea and the Mediterranean. Meantime its great volume of fresh water served as a barrier between the salt-water faunæ of the two seas. The Amur at the present day forms, in the same manner, a barrier between the salt-water faunæ of the Sea of Japan and the Sea of Ochotzk, the former of which has a tropical and the latter an arctic character.—*Verhand. der K. K. Geol. Reichsanstalt.*

The water of the Dead Sea, according to the recent analysis of H. Fleck (" Repertorium Anal. Chemie "), contains per litre:—Potassium chloride, 16·9 grms.; sodium chloride, 74·051 grms.; sodium bromide, 5·024 grms.; magnesium chloride, 128·105 grms.; calcium chloride, 35·355 grms.; and calcium sulphate,

1·211 grms.; in all, 260·646 grms. of salts. The specific gravity, at 15° C., is 1·1861.

J. Brautlecht ("Virchow's Archiv. für Path. Anatomie") has detected pathogenic Bacilli in the urine of patients suffering from typhus, in suspicious waters, and on the surface of putrescent Algæ. He finds that, in contrast to non-pathogenic Bacteriaceæ, they possess no reducing power, and do not, *e.g.*, convert nitrates into nitrites. They were capable of cultivation in water containing gelatine and ammonium phosphate. If injected under the skin of rabbits they occasioned fatal fever, resembling typhus with abdominal complications.

According to the "Berichte der Deutsch. Chem. Gesellschaft," alantoine occurs in the vegetable organism.

Herr Probst ("Jahreshefte Verein. Naturkunde Würtemberg") seeks to account for the chief phases of geological climate without the aid of cosmic changes. He explains the uniformly high temperature of the Silurian, Devonian, and Carboniferous epochs by a predominance of sea, and by the assumption of constant cloudiness in high latitudes, with bright skies in the tropical regions. A denser atmosphere and a somewhat greater internal heat of the earth would be sufficient to account for the occurrence of reef-forming corals in Grinnel Land. The gradual increase of land accounts for the decreasing uniformity of climate, whilst the Glacial epoch is ascribed to the upheaval of lofty mountains in continuous masses at the end of the Tertiary period. The action of erosion gradually reduced the level of the mountains, and opened valleys in their compact masses, thus leading to the return of a milder climate.

H. H. Haworth ("Geological Magazine") contends that the mammoth "was extinguished by a sudden catastrophe involving a great diluvial movement over all Northern Asia, accompanied by an equally sudden and violent change of climate." A specimen of *Rhinoceros tichorhinus* has been obtained in such good preservation that the death of the animal can be plainly traced to asphyxia.

Numerically and financially speaking the late "Jubilee meeting" of the British Association at York has been most successful. The proceedings at the "Economical Section" would, however, have been much more suitable for a Chamber of Commerce. Unless the Committee see their way to the abolition of this Section, we fear the Association will gradually degenerate into a Political Discussion Society. For debates on "free trade" and "fair trade" there is ample scope elsewhere.

According to Prof. Winchell ("Popular Science Monthly") the copper miners of Lake Superior were the Red Indians, and no some distinct and antecedent race.

Mr. D. V. R. Manley, writing in the same journal, calls attention to the "midget," a minute yellow insect infesting the islands of Lake Erie. Like the chigoe (*Pulex penetrans*) of the West Indies, it has the habit of burrowing under the human skin, and setting up intense irritation.

M. F. A. Forel, in the "Archives des Sciences Physiques et Naturelles," maintains that the advance and retreat of glaciers do not depend on the amount of snow in the last winter, or on the higher or lower temperature of the summer, but on the periodic increase or decrease of snow-fall through a number of years. A periodicity of ten, twenty, or in some cases of more years, is observed in the alternate growth or decrease of each glacier.

According to M. H. Fayol ("Comptes Rendus") the fossil trees found in an upright position in the coal strata have not grown as they are found, but have been deposited by water.

Pflüger and Oscar Loew (Pflüger's "Archiv für Physiologie," xxv., p. 150) conclude that living protoplasm possesses in a high degree the power of reducing the precious metals from their solutions, but loses this property when dead. The phenomenon known as life is probably conditioned by those reductive groups of atoms—probably aldehyde groups.

M. Ph. van Tieghem ("Soc. Botanique de France," xxvii., p. 353) has observed, for the first time, fungoid vegetation in oil. One of the forms was incapable of cultivation in moist air, and could not be determined. The other was found very similar to *Verticillium cinnabarinum*.

According to Stebler ("Naturforscher," xiv., 332) light has a greater influence in promoting the germination of certain plants (grasses of the genus *Poa*, ferns, &c.) than heat.

The "Archives des Sciences Physiques et Naturelles" (ser. 3, tome v., p. 516) contains a very important memoir, by Prof. A. Agassiz, on the palæontological and embryological development of the *Echini*.

It is reported that the "Colorado beetle" (*Doryphora decemlineata*) has obtained a foothold in Belgium, near the French frontier.

A Curculio (*Phytonomus punctatus*) which has long been known in Europe, but has occasioned no injury, has, according to the "American Naturalist," made its appearance in the State of New York. It is doing much damage to clover.

According to the "American Naturalist" a certain Dr. Jones, of the Concord School of Philosophy, saith—"Of the idea of Evolution and of the origin of species, we must think some worthier thought than that of a monkey or gorilla rubbing off his tail, and otherwise improving his condition, until, through

natural selection of condition, he finds himself a spiritual being with an immortal soul." Might we remind this Dr. Jones that a gorilla has no more tail to "rub off" than a "Concord Philosopher"?

On the same occasion a Mr. Alcott held that, "instead of coming up from animals, animals have descended from men, and were possible only because man made himself a beast first."

Prof. His has, very characteristically, sought to deny the existence of a rudimentary tail in the human embryo. He denies the existence of supernumerary vertebræ in the "caudiform appendage." Prof. Gerlach has shown, however, in an elaborate memoir ("Gegenbaur's Morphologisch. Jahrbuch"), that such supernumerary vertebræ actually exist.

M. Emile Delaurier ("Les Mondes") considers that the excessive velocity of comets causes a vibration of the ethereal matter of space, and producing heat and light, and thus gives rise to the so-called tail. He contends that the popular belief in the influence of comets upon the temperature is not groundless.

According to H. C. Bumpus ("American Naturalist") the yellow-bellied woodpecker drinks the sap of the birch-tree. "The humming-birds were very thick round the tree, sucking the sap where it was running from the holes; there were also butterflies and moths around it."

[We have often captured Lepidoptera by boring holes in trees and seizing the insects as they came to drink.—Ed.]

Dr. C. Brame ("Les Mondes") maintains that cyclides and cyclidary formations appear general in nature, not merely in organic matter, but in plants and animals, of which he gives instances. He argues that the chemical law of multiple proportions is applicable to the relative dimensions of the central object and of the cyclide or the concentric cyclides.

H. C. Heller ("Wiener Akad. Wissenschaft") observes that genuine Alpine forms show a strong tendency to melanism. *Lacerta crocea* and *Polias prester* take in the higher mountains an almost black colouration. The mountain salamander (*Salamandra atra*) is intensely black. The fish in the Alpine lakes have dark colours. With the exception of the Chrysomelidæ most of the insects are black or deep brown, and the higher we ascend the darker become their colours. This is the more interesting as the Alpine flora is distinguished by the brightness and purity of its colours.

According to "L'Union Medicale" a crucial experiment on M. Pasteur's system of protecting cattle from anthrax, by a kind of vaccination, was performed in May this year, near Melun, and was attended with complete success.

Mr. Herbert Parsons, writing in the "Medical Press," observes that "the immediate effects of opium are far more pleasant and perfect than those of alcohol, while permanent injury to the system is not so certainly a final result."

M. G. Delaunay submits to the Academy of Sciences certain interesting results on the action of strychnine, applicable in part to that of other poisons. He finds that of two frogs, the one large and vigorous, and the other small and feeble, the former is more severely affected by an equal dose of strychnine. A well-fed frog is more susceptible to the poison than one which has fasted for some weeks. A frog which has been walking and jumping suffers more severely than one which has been at rest. A frog fixed with its head upright is less strongly attacked than one placed in the reversed position. He remarks that the bite of a viper has little effect upon a dog when at rest, but is rapidly fatal if he is fatigued with hunting, &c.

The existence of fossils in meteoric stones has excited much discussion, and is said to have been admitted by Mr. Darwin. According to "Science" the Helmholtz-Thomson hypothesis, of the origin of life on the earth, has become a tangible reality. (But supposing that fossilised organisms have reached the earth from the realms of space, does it follow that living organisms have been also thus transported?)

The "Medical Press and Circular" maintains that the cases of irreparable injury received in schools from corporeal punishment are beyond number. (How is it that none of our humanitarians feel called upon to interfere?)

According to an analysis of Prof. Frankland the water of the Holy Well of Zemzem, at Mecca, is sewage more than seven times as rich as the average sewage of London.

At the Cincinnati meeting of the American Association for the Advancement of Science, C. S. Minot endeavoured to show that man is not the highest animal. We shall examine this paradoxical memoir on a future occasion.

M. Axel Blytt ("Botanische Jahrbücher für Systematik u. Pflanzengeographie") concludes from the facts of organic geography, that the temperature of the sea and the strength of oceanic currents are subject to periodic changes. He finds in the distribution of the various groups of the Norwegian flora evidence that dry periods with a continental climate, and moist periods with an insular climate, have repeatedly alternated since the ice age. He considers that the study of these climatic changes will show that the distribution of species follows laws as simple as those manifested in the revolutions of the planets.

Mr. J. W. Stephenson considers the swinging sub-stage of comparatively little value, as it is unable to utilise the full aperture of the modern homogeneous immersion objectives: this can only be done by means of immersion illuminators, which are used on the ordinary rigid sub-stage arrangement.

Dr. H. R. Rogers ("Progress of Science") considers the sun not "the manufacturing place and distributing reservoir of actual light and heat," but "the source whence the whole solar system is supplied with the invisible potential light and heat which become developed where required." The great central orb may therefore be regarded as like unto the earth on its surface and in its surroundings, viz., a dark, cold, habitable body.

The newly-invented instrument, by means of which the exact position of the bullet in the body of the late President Garfield was supposed to be traced, must of course fall into discredit now the autopsy has shown that its indications were erroneous.

It is reported that M. Pasteur is about to visit the Bordeaux lazaretto, in order to make a special study of yellow fever, and determine whether it is due to a parasite, and if it can be prevented by a kind of inoculation.

"Il Progresso" considers that sulphuric acid is slightly volatile at ordinary temperatures.

Dr. Alcott, of the "Concord School of Philosophy," pronounces matter "a precipitate of thought"—whatever that may mean.

According to "L'Union Medicale" the ancients employed electricity as a therapeutic agent, making use of a living torpedo (*Raia torpedo*) as a source of the agency.

A Sanitary Congress has been opened in Vienna.

Signor O. Comes ("Atti della R. Accademia dei Lincei") has published the results of his investigations concerning the influence of light upon the transpiration of plants. He finds that the emission of watery vapour from a plant depends not merely on the agencies which influence the evaporation of water from an open surface, but also on the action of light, and consequently reaches a daily maximum shortly after noon. In case of a coloured organ only those rays of light are effective which are absorbed, and not those which are reflected.

NINETEENTH YEAR OF PUBLICATION.

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THE

JOURNAL OF SCIENCE.

NOVEMBER, 1881.

I. MINIATURE PHYSICAL GEOLOGY.

By C. Lloyd Morgan, F.G.S., Assoc. R.S.M.

I.

SOME four years ago I described in the columns of "Nature" a few observations I had made, during seaside walks, on the subject of Miniature Physical Geology. The observations were such as might be made by anyone at almost any time. Still I thought that lessons were to be learnt in this way. And I ventured to draw attention to some of these lessons. I concluded my communication to "Nature" with these words:—"My object in drawing attention to such matters of ordinary observation is to induce young students of physical geology to go out and observe these things for themselves. If, after a morning's study of Lyell's 'Principles,' the young geologist will devote an hour's careful observation to miniature physical geology, with sketch- and note-book in hand, he will find that his conceptions have a reality and a solidity which could not have been evolved in the study at home, while at the same time he will find it more easy to grasp, when he shall have the opportunity, the workings of Nature on a grander scale." In this paper I propose to treat this subject a little more fully, to describe shortly such simple observations as I have made, and to point out how frequently we may see for ourselves, during a seaside or hillside ramble, representations on a small scale of some of the grandest works of Nature.

There are few of us, I imagine, that have not felt the advantages of pictorial illustrations as aids to comprehension. But in some subjects working models are more

valuable aids than pictures. Now I look upon a little streamlet as a working model, supplied by Nature herself, to illustrate the actions of great rivers. And I would ask my readers to look upon all the observations I am about to bring before their notice as small-scale exemplifications of the ways of Nature. Taken by themselves they are trivial to a degree. Taken in connection with the phenomena they exemplify, they may not perhaps be without interest.

II. *The Catchment Basin of Rivers.*

On almost any flat sandy shore one may watch the gradual establishment of miniature drainage areas and catchment basins. On one occasion, when I had been collecting fossils from the tertiary beds at Pegwell Bay, in Kent, I was caught, as I crossed the smooth flat left by the receding tide, in a heavy thunder-shower. To my eye the surface seemed perfectly even; but as I stood and watched, the rain-drops collected into definite channels: these soon formed miniature rills, uniting into miniature streams, which ere long in their turn united into a miniature river. This kind of illustration is, however, so well known that I should not have drawn attention to it here had I not been able, in less than an hour and a half, to watch the separation of a mud-surface, to all appearances quite even, into a number of separate and distinct drainage areas, each of which resembled a model of the catchment basin of some great river.

III. *The Cutting Sideways of Rivers.*

On almost any stretch of sand the action of a miniature river on its banks may be watched. These little streams seldom or never flow in a straight course. I have sometimes on a sandy shore done my best to make a straight run for a little stream, and then, damming up its bed, deflected the miniature river into the artificial canal I had thus constructed. For a little while the stream would continue to keep a straightforward course; but very soon some slight obstacle on one side would throw the main current towards the opposite bank. The result of this is soon apparent. This bank recedes, and, as it does so, it ceases to be a shelving *slope*, and becomes a tiny *cliff*. It continues to be rapidly undermined by the action of the stream, and the upper portions now and again topple over with a little splash into the water. In this way a bold curve is formed, which *increases in length down stream*. In the meanwhile, on the opposite shore of the

river, sand is deposited, and as the river cuts its way downwards this portion is left high and dry.

But the mischief once begun rapidly spreads. The formation of one such curve sets the stream a swinging through the rest of its course. Now on one side, now on the other, are the banks eaten into, until the course has become marked by sinuous curves, local conditions causing some of the curves to be more pronounced than others. All the curves, however, have a tendency to *advance down stream*. When a curve has in this way become comparatively long, the miniature river often tends to assume a straighter course; it recedes from its bank cliffs, and soon a tract of comparatively level dry land separates these banks from the stream. This is generally due to the lengthening of the curves above. In fact, a little consideration will show that the gradual advance of the curves down stream will have a tendency to produce a broad valley through which the river will wind. These miniature valleys have often beautifully-marked river terraces on either side, showing the length of swing of the river on each occasion that it oscillates to and fro. There can be little doubt that during each swing the river cuts its way downwards to some extent, and that therefore the terraces formed in succession on the left and right banks are at slightly different levels in a descending series; but this I have not been able to see in miniature.

How marked a feature broad valleys and river terraces are on a large scale I need hardly remind the readers of this Journal. Memphis, on the Mississippi, stands on such a terrace. Sections of any tolerably large river-valley—that of the Thames, for example—show this well, but to make out a succession of these terraces in a large river valley is not easy. They may be more satisfactorily studied in smaller tributary streams. I remember an admirable instance near Penrith, in Cumberland. But for my own part I confess that the study of miniature valleys helped me much in the comprehension of this subject.

Very plain are the evidences of the swing of the stream in great rivers. No one who has passed down the Mississippi, for example, can have failed to notice that the opposite banks are generally very different in character. The one shelves down into shallow water; the other is cliff-like, often 20 feet high or more, and has deep water under it. The shelving bank is in fact advancing on the river. The steep bank is being undermined by the river. All the settlements on the banks of the Mississippi are on the steep side; there are none on the shelving bank. The reason of this is

obvious. Steamers can come alongside the steep bank; they cannot get near the other. In any case, however, such settlements cannot be permanent. If they were built on the shelving bank the river would be constantly receding from them, and they would have to follow it. As it is they have to recede before the advancing river. I was informed at one place (Point Pleasant), on the Mississippi, that the river had advanced nearly three miles in sixty years. In 1876 I came across an instructive example of this kind of action. When I was in Lancashire a gentleman showed me a map of his estate made in 1747, in which year the River Lune ran, if I remember right, within a hundred yards of his house. In 1876 the river was fully one-third of a mile distant, and a river-terrace about 50 yards farther off marked the limit of the swing of the stream in that direction. As the river forms the boundary between two properties, belonging say to A and B, one gains while the other loses, as the channel shifts. In this case A gained and B lost; whereupon B put up a stone groin, to throw the force of the stream on A's bank, that he might regain some lost ground. A in return put up a similar groin, to catch the brunt of the stream and turn it back upon the opposite bank. When I was there I saw several such artificial constructions, which will probably have the effect of checking the swing of the stream.

On the Mississippi I have seen great masses of the steep bank fall, and felt in a large steamer the wave produced. Mr. Bates, however, has a striking passage describing similar falls on the Amazons. "We saw the work of destruction," he says, "going forward on the other side of the river, about 3 miles off. Large masses of forest, including trees of colossal size, probably 200 feet in height, were rocking to and fro, and falling headlong one after another into the water. It was a grand sight: each downfall created a cloud of spray; the concussion in one place causing other masses to give way a long distance from it, and thus the crashes continued swaying to and fro with little prospect of a termination."

IV. *The Formation of a Cut-off.*

Under certain circumstances the action of a river upon its banks produces a curious effect. This I have seen in miniature on one occasion only. On the muddy flats of Pegwell Bay a little stream bent round in a great loop something like the capital Omega in the Greek alphabet. The flow of the water past the curves caused the concave banks to recede, thus narrowing the neck of land which separated them.

This continued until the isthmus of land was eaten through, whereupon there was at once a flow of water through this opening, which was in consequence soon broadened and deepened to such an extent as to admit of the passage of the whole river through this channel. The loop was thus left as a horse-shoe lake in connection with the river.

Those who have passed down the Mississippi from St. Louis to New Orleans will doubtless be able to recollect passing through more than one "cut-off" of this nature, and thus shortening the journey by perhaps eight or ten miles. An instance of the same thing, which took place on the Juruá, a Brazilian river, is described by Brown and Lidstone in the following sentence;—"Within the last six years the river has altered its course, by cutting through a neck of land, thereby taking a short cut and abandoning a long curve." The upper end of this curve was subsequently silted up.

I remember well, as a boy, anxiously watching the narrowing of the isthmus separating the two concave banks of such a loop on the Wey, a tributary of the Thames. And I have a vivid recollection of the occasion of my first "shooting" in my canoe the rapid which was formed when the bank had at last given way.

V. *The Formation of Islands.*

To revert now to the miniature river: in the midst of the stream sand-islands are from time to time formed, often caused by a stranded stick, and partly no doubt by the deepening of the main channel on one side or the other; but no sooner has the sand of which they are composed become dry than the treacherous stream commences the destruction of that which it has itself produced. This it generally begins at the upper end, and it is not uncommon to see construction and destruction going on at the same time; destruction above, construction below. Where this double action takes place the island is not stationary, but in motion down stream.

Whether this motion down stream has been observed on a large scale I do not know; but that the construction and destruction of islands take place with considerable rapidity in some of the larger river channels there can be no doubt. In one of my note-books I find the following remarks, written on board a Mississippi steamboat:—"You can see islands in all stages of formation in the river. First, an extensive shallow or shoal; against the upper portion of this logs and

snags get stranded, and these protect the rest from the force of the current. In the next stage the sand-banks are higher, having probably been built up during a flood. Then a few cotton-wood shrubs, the growth of which is very rapid, are seen here and there. These in two or three years cover the island, and attain a height of 14 or 15 feet. Beneath them springs up a considerable undergrowth of cane. The island is now complete, and ready to be ere long washed away by some change in the direction of the current." I find, too, another note written on the Parà branch of the Amazons:—"At Parà the river is, I am informed, 9 miles wide, and is studded with many islands. Not unfrequently some of these islands are washed away, and fresh ones formed. For instance, a few years ago, Parroquet Island stood some few miles below the town: this has disappeared, and on the other side of the stream a new island,—the Ihla Nova,—has arisen and is covered with a luxuriant vegetation."

VI. *Changes of Depth in River Channels.—Sand-dragging.*

As illustrating the varying depth of the channel in large rivers, the following observation, made on the sands near Ramsgate, is perhaps not uninteresting;—The stream had to pass through some narrows between a miniature chalk cliff and some other obstruction. The force of the current here dug a hole in mid-stream. This hole gradually lengthened down stream. Then a little ridge began to separate it into two parts, an upper and a lower. The lower depression advanced, and was followed by the ridge. By this means the upper depression was lengthened, until it was also separated into an upper and lower part by a ridge. In this way several depressions in the bed of the stream were formed. These advanced down stream, and the lowest of them was some considerable distance from the narrows, but below this point the depressions were so far filled in as to be indistinguishable. This is a good instance of the way in which fine and coarse sand is *dragged* along the bottom. Of course in the case of a large and deep river this action would not be so noticeable; but I imagine that the estimate of Messrs. Humphreys and Abbot, that the Mississippi pushes along the bottom sand and gravel equal to about one-tenth of the mud held in suspension by the river, is by no means excessive.

VII. *The Cutting Downwards of Rivers.*

The best miniature examples I have seen of rivers eroding for themselves deep channels, by cutting their way downwards, were near the Barton cliffs, in Hampshire. But almost anywhere one may notice this general deepening of channel giving rise to a valley or ravine. There was, however a special interest in one example I saw at Barton, which induces me to mention it here. At the base of the cliffs was an eroded surface of Barton clay which was comparatively tenacious. But the surface was not even, the hollows being filled up with a less tenacious mixture of mud and sand. Across the whole of this flowed a little freshwater stream, which had cut its way 6 or 7 inches into the surface. And it was interesting to notice that where the clay was tenacious the valley sides were steep, almost precipitous; where the stream passed over the mixture of clay and sand, the sides were sloping at a very gentle angle. This gentle angle could not, however, I think, have been produced by the stream alone, but must have been the result of either rainfall or the spray from the waves at high tide.

Those who have seen anything of river action on a large scale will have noticed how marked an effect the hardness of the rocks has upon the form of a river valley. Where the rocks are soft the valley is very broad and open; where the rocks are hard the valley assumes the character of a gorge. Of this the rivers which take their origin in the Weald, and flow through the South Downs, afford well-known examples. The Rhine gives us another illustration. And if we read the "Geological Report of the American Survey of the Colorado of the West," we find a description of the same thing:—"Where we passed through the first of these ranges (the Purple Hills) it has nearly a N.W. and S.E. trend, and in the immediate vicinity of the river is composed of a gray massive granite, which, yielding somewhat readily to the action of the elements, has formed slopes receding from the river, giving the pass an outline strikingly in contrast with that of most of the cañons cut in the porphyrite rocks higher up" (p. 21). One of these ravines, the great cañon, as is well known, has nearly perpendicular walls, which are in one place more than a mile high. Nevertheless the American geologists ascribe its formation entirely to the action of running water.

An instructive small scale example of a river thus cutting

its way downwards may be seen on the Cape Flats, not far from Cape Town. Near the Diocesan College, Rondebosch, runs a small stream, known, I believe, as the Little Black River. As I walked along the dry bed of the stream I found my path continually obstructed by roots, which run right across the channel from one bank into the other, and are at a height varying from $\frac{1}{2}$ a foot to 2 feet 6 inches from the present bed of the stream. It is clear that these roots cannot have got across from one bank to another as the channel now is. They must have passed beneath the former bed of the stream, and they now remain to show how rapidly the stream is cutting its way downwards.

(To be continued.)

II. LATENT HEAT.

By Charles Morris.

(Concluded from page 533.)

A QUESTION now arises as to the efficacy of this process of equilibration of temperature. In truth the differences of sensible heat between the orbs and the matter of space are being but very slowly rectified, if at all. The principal, and perhaps the only, heat emissions from the orbs into space, are in the form of radiant heat. This is a surface emission from the spheres, and it possibly never becomes static heat until it reaches the surfaces of other spheres. The vast volumes of motive energy thus poured into space may pass through a completely transparent medium, and, if so, can have no effect in raising the temperature of interspheral matter. The spheres tend, in this manner, to produce temperature equilibrium among themselves, but may fail to affect the matter of space.

The radiated energy is superficial only, and must depend for its supply upon a very slow conduction of internal heat to the surface, or on a more rapid convection while spheres continue liquid or gaseous. In one or the other of these modes the internal heat of spheres reaches their surfaces, and is thence radiated outwards. There is probably no heat conduction through the atmosphere. There is a certain

degree of convection, but there is no good reason to believe that sensible heat is transferred to interspheral matter in this mode. And as radiated heat may not affect the temperature of the matter of space, it is quite possible that the diversity in temperature is not being, and cannot be, rectified.

But heat exchange between the spheres is active. Every touch of a solar ray on a planet conveys heat energy from the sun to the planet. Thus the inequality of sensible heat between the orbs of space is being slowly overcome. This inequality is not alone a result of the more rapid cooling of the smaller orbs, but arises largely from the differences in gravitative vigour of the orbs. Gravity on the sun is much greater than on the earth. Compression of the internal matter of the sun must greatly exceed that of the earth. Consequently the specific heat of solar substance must decrease, and its latent heat become sensible, to a much greater extent than in the earth. In consequence of this the earth could never have reached the temperature of the sun, and possibly its highest temperature was far below the present solar temperature. In like manner the highest degree of lunar temperature must have been considerably less than that of the earth. This is, doubtless, one main cause of the heat inequality between the larger and smaller orbs, the greater rapidity of cooling in the latter being the other cause. And from this results the long process of equilibration to which all existing planetary activity is due.

Yet it must not be supposed that when equilibrium of temperature is finally attained the spheres will cease to emit heat. For radiation from the spheres is not to other spheres, but to the matter of space, and the falling of these rays on other spheres is, in a certain sense, accidental. When, however, temperature equilibrium is established between the spheres, thenceforward each will absorb as much radiant heat as it emits, and the radiations of heat into space will be just balanced by the receptions of heat from space. Yet this final equilibrium of heat emission will not be an equilibrium of temperature. If we take the sun and the earth as illustrations, we find the earth receiving heat from the whole hemisphere of the sun, and returning heat only from its own much smaller hemisphere. The area of the sun's hemisphere is 12,000 times that of the earth, and if the temperatures of each were equal, and each radiating heat with equal energy to the other, the total heat received by the earth from the sun must considerably exceed that received by the sun from the earth. Necessarily, then, the surface temperature of the sun must

fall considerably below that of the earth before their heat emissions can be in equilibrium. The same rule, of course, applies to all spheres which exchange heat with each other, and thus a final equilibrium of heat exchanges could not be an equality of temperature in the orbs of space.

Of the heat emitted by the sun only the 227 millionth part is caught by the planets, and this is nearly all yielded again to space. The vast remainder of the solar radiations flows out towards the remote spheres of the universe. Each of these receives but a minute fraction of this heat. Whether it shall be all eventually absorbed or reflected depends upon the improbable contingency that every possible straight line drawn outward from the sun shall somewhere meet a sun, a planet, or a smaller mass of condensed matter. It is the same with every other orb. Thus the heat radiated by the orbs into space can only in a minor sense be said to employ itself in producing temperature equilibrium between these orbs, since the great volume of it must wander unceasingly through space. Therefore space receives, in the radiant form, the excess temperature of the spheres, and is becoming, as it were, crowded with such ever-crossing rays.

But is the transparency of the matter of space to radiant motion perfect? May not its capacity for these rays be limited? A good electric conductor will transmit feeble currents with little or no resistance, yet will strongly resist powerful currents, and partly convert the electricity into heat. The same rule may apply to radiations, which may become more and more converted into static or sensible heat as the current of heat-rays becomes stronger. Crossing, or reversely moving rays, or parallel rays in different phases of vibration, may also partly obliterate each other, and yield static heat vibration. It is possible, therefore, that radiant heat may slowly become converted into static heat in space, in which case temperature equilibrium between all matter may be slowly arising. If it ever be completely established, then the assumed original equilibrium of temperature, and of absolute heat in nebular matter, will be succeeded by a final equilibrium of temperature and an extreme diversity in absolute heat, the latent heat of the rare matter of space being immensely greater than that of the dense matter of the spheres. The absolute heat-contents, or motive energy, of a molecule at the centre of a dense sphere, must be greatly less than that of a molecule in interstellar space to give them the same temperature resistance, the one being vigorously aided in its resistance by its fellows, the other having to depend solely on its individual energy, and the one

having to fight for the possession of a far smaller field of free space than the other.

It might be well to cease at this point, yet there are certain other interesting possibilities of the continued evolution of the universe, which may be briefly considered. Let us suppose that gravitation affects all matter, and that the rare matter of space is more condensed around the spheres than in interastral space. In such a case the density of this matter might greatly differ. But if all matter be in temperature equilibrium, the latent heat of the very rare interastral matter must considerably exceed that of the denser matter surrounding the spheres. But these spheres are rapidly plunging through space, and presumably leaving regions of condensed matter to enter regions of rare matter. A double result must follow. The condensed matter of the first region, being relieved from attractive pressure, must rapidly expand, and its temperature fall. The rare matter of the second region, being exposed to attractive pressure, must rapidly contract, and its temperature rise. In this manner a considerable disturbance of temperature equilibrium might result. And this disturbance would be augmented if chemical disintegration accompanied the first process, and chemical integration the second. Radiation would recommence from the heated to the chilled space, and from heated space to the spheres. And life, with all its powers, might arise from such an incessant disturbance of temperature equilibrium by the moving spheres.

But such an action could have but one result. A constant breaking away of the spheres from attracted matter must tend to decrease the motion of the spheres themselves, and eventually bring them to rest. And the heat activity produced in this process would virtually amount to a conversion of the energy of spheral motion into heat energy. It therefore could be but a temporary process.

Another result of such a frictional resistance must be the gradual yielding of the smaller spheres to the attraction of the larger, and a final aggregation of all spheres into a limited number of huge orbs. Only, in fact, after all mass motion had finally ceased, and gravitation had produced its utmost possible change in the distribution of matter, could a fixed equilibrium of temperature arise, and all motion be reduced to the heat vibration of separate particles.

This cosmical evolution, carried to this conceivable ultimatum, would consist in a gradual change from an original condition of partial homogeneity of distribution in matter, temperature, and absolute heat, to a final condition of homo-

geneity of temperature, but of great heterogeneity of distribution in matter and its absolute heat contents. And the sole cause of this long-continued change would be the attraction of gravitation. Could this attractive influence act sufficiently long upon the matter of any extensive region of space, without resistance from any reversing influence, the series of changes indicated in this paper might all take place. Nor would the series of changes end here. They could not cease until the utmost effect of gravitation had been produced.

If we consider the case of some great ultimate orb, at rest in space, what would be the final result of its attraction? Assuming that all substance is subject to attraction, the tendency would be to condense the matter of space around this orb. But such condensation must have its limit. It could not possibly continue until all matter was solidified, and space denuded of its contents. For it must be remembered that the effect of gravitation is really twofold. The pull on each separate particle is excessively slight, and diminishes rapidly outward from the solid surface. The weight of gas volumes is more largely a result of their compression by the gravity of atmospheric matter above them, than of their intrinsic attractive energy. But in remote space this compression must be inappreciably slight, and the attractive energy be so reduced that but little density could exist. Therefore, however intense the attractive force of the great final orb, it could not possibly reduce to solidity the matter of space. However dense the immediate atmospheric portions of this matter, the remote portions must continue in a state of excessive rarity, and but slightly affected by gravity.

Thus the final state must be an arrangement of matter in successive zones, varying gradually from the utmost density at the centre of the orb to the utmost rarity at the outer borders of its attractive control. Accompanying this would be a reverse distribution of heat, the capacity for heat being greatest in the zone of rarest matter, and least in the densest zone. At the centre of the orb heat energy might almost cease to exist, the motive vigour necessary to give this highly compressed matter a certain temperature being excessively less than that needed by very rare matter.

We may briefly glance at another possible result of the process of evolution here indicated. Chemical activity has accompanied it from its beginning, and may accompany it to its end, but the effects of chemism have become successively more and more complex. For a long period inor-

ganic chemism was very active upon the earth, and doubtless very energetic displays of motive force took place. Now inorganic chemical activity has almost ceased to exist, and organic chemism has taken its place. But to the full development of organic action violent and irregular displays of force are very adverse, and we find that organic life has advanced to higher and higher forms in proportion as the energy of inorganic action decreased. When complete regularity in material conditions and changes takes the place of the present irregularity, organic life may reach its highest development, while not only inorganic activity may cease to exist, but also the lower stages of organic activity. This seems the tendency of chemical change, and we have warrant, therefore, to look forward to a period in which all free energy will be exerted in the production of living forms, the only active inorganic agencies being those necessary to the production of vegetable forms.

For such a result it is not necessary that the kinds and conditions of matter, and degree of temperature, shall continue precisely as they exist at present upon the earth. Nature may have far more versatility in this respect than she is usually credited with. Thus in the production of terrestrial organic life just such materials are used as are most available, the gaseous carbon and oxygen, and the liquid water and ammonia. Of the solid constituents of the earth only those are employed which are widely diffused and readily soluble. Thus organic life employs here all the material which is in a condition adapting it to chemical action, and in quantities closely conformable to the chemical activity and availability of each element. And one element is frequently replaced by another when the latter becomes more available.

As it is possibly unimportant what materials take part in organic integration so that their physical condition is such as to adapt them to active chemical change, so it may be unimportant what the ruling temperature is, if it be only such as to preserve matter in this necessary physical condition, and to excite its chemical activity. On other spheres than the earth life may flourish under widely different conditions, both as to material and to temperature. And finally it is unimportant whence comes the energy employed in organic chemism. On the earth the energy of the solar beams is employed, this being the most available and vigorous source of motive energy. But elsewhere heat force arising from local sources might be employed; and if this energy were applied directly and wholly to the furtherance

of organic chemism, it would need to be far less in quantity than that of the sun, of whose total radiations to the earth only a minute fraction is thus employed. It seems quite possible, then, that organic life may exist elsewhere under conditions strikingly unlike those existing upon the earth, and may continue to exist and develop through great changes in the future conditions of matter.

Throughout this paper I have confined myself to the probable results in the case of attraction being the only force acting upon matter, or to the contingency of the material contents of some extensive region of space being enabled to display all the possible results of gravitation, without reverse influence from without. But if, as argued in my paper in the "Journal" of November, 1880, the amount of repulsive energy in matter just equals that of attractive energy, a reversal of all these changes must eventually occur, and every spheral condensation of matter be sometime succeeded by a nebular rarefaction of the same matter.

III. THE VACCINATION QUESTION RECONSIDERED.*

We have exceedingly little sympathy with "movements," agitations, and societies for the abolition of this, that, or the other. Nor do we share Mr. Taylor's touching faith in "the common sense of our countrymen," or in "the force of truth when not suppressed." We hold that no people are so readily led astray by sophists and rhetoricians as are the English. At the same time we must avow ourselves agreeably disappointed with Mr. Taylor's pamphlet. Instead of sensational appeals to the emotions and prejudices of the ignorant, and of any misrepresentation of opponents, we find sober reasoning, candour, and courtesy greater than is sometimes shown by

* Vaccination: a Letter to Dr. W. B. Carpenter, C.B. By P. A. TAYLOR, M.P. London: Allen.

Has our Vaccination Degenerated? By C. CAMERON, M.D., M.P. In "Fortnightly Review."

Dr. Carpenter in his controversial writings. Still, an undercurrent of dislike to the medical profession is not entirely wanting.

Further, the subject is not one of those which can only be rightly handled by men of special scientific attainments. Were such the case we should be the first to refuse outsiders the claim of being heard. But here is a certain phenomenon —the smallpox. Here also is a certain agency, *n*, which is asserted to put a stop to the occurrence of such phenomenon. If this assertion is correct, then in proportion as *n* becomes more general the smallpox must become rarer. Whether such is the case or not any educated man is able and entitled to judge, if the statistics of vaccination, and those of smallpox cases and smallpox mortality, are fairly laid before him. The matter is here somewhat complicated by a circumstance to which Mr. Taylor has very fairly drawn attention : smallpox, namely, is not—like, *e.g.*, phthisis—a constant disease which carries off year by year, or decennium by decennium, approximately the same number of victims. On the contrary, it makes its appearance in irregular epidemics. One year it may be almost absent, whilst the next it may assume quite alarming proportions. This fluctuating character gives, it must be conceded, great scope for a disloyal manipulation of statistics—a circumstance of which we fear the disputants on both sides have sometimes, though perhaps unwittingly, availed themselves.

We will open our enquiry by considering what grounds would justify an objection to the Compulsory Vaccination Act, and an agitation for its repeal. To us there appear two only as legitimate, viz., a want of efficiency and a want of safety, or, of course, the two combined. By "want of efficiency" we mean the failure of the operation to insure immunity from smallpox, and by "want of safety" we refer to the possible introduction of other—and worse—diseases. Of these grounds the latter, if demonstrable, is incomparably the graver. Indeed if vaccination, though less effective than its champions suppose, is at any rate harmless, the agitation against its legal enforcement is scarcely warrantable.

As to other than physiological grounds, we refuse to listen to them altogether. If the operation is a preventive of smallpox, and exposes those who submit to it to no other dangers, we hold that the State is bound to enforce vaccination upon its citizens. With those who think that the individual is at liberty to make his house a *nidus* of infection we can hold no discussion, because there is no common principle

to which both sides can appeal. Hence the "natural rights of parents" can be taken into account when, and only when, the uselessness and the perils of vaccination shall have been clearly shown.

It would be interesting to trace what was the original standpoint of the anti-vaccination movement. Did the recusants start with a conviction of the inutility and the risks of the supposed safeguard? Or did they take up originally a theological or political position, and have afterwards sought for medical evidence in its support? In the latter case we must hold the movement utterly irrational in its rise, though of course any sound arguments which may have been since brought forward are not invalidated by original error.

The anti-vaccinationists rightly lay great weight upon the possible communication of syphilis by the vaccine lymph. To this we may refer below. But we would ask, Are not some of their leading spirits also agitators against the Contagious Diseases Act? And if so, are they not guilty of a slight inconsistency in defending the existence of the dire affection whose communication they so much dread?

But we must now turn to Dr. Carpenter's eight propositions, the first seven of which assert, in slightly varied forms, the efficacy of vaccination, whilst the last seems to sneer at the existence—or at least the extent—of the danger of the simultaneous transmission of other diseases. Every one of these propositions Mr. Taylor traverses, not without ability, and to a certain extent successfully. If we do not misunderstand him, however, he maintains that vaccine is not, and never was, a protective—an evident exaggeration. It is not in our power to verify all his quotations, and to refer to the statistical returns he has made use of. But there are certain broad open facts which weigh in his favour. No one will dispute that in the first two quarters of the present century vaccination was not nearly so general as it is now. It was confined to what are commonly called the upper and middle classes, and even amongst these it was far from universal. Yet prior at least to 1838 a person with a pitted face was looked on as a curiosity—a survival from the days of ignorance. In our childhood we constantly heard the small-pox spoken of as an extinct evil. None of our schoolfellows or associates had been attacked by it, nor had, apparently, any of the children or young people whom we chanced to see in the streets. No one hinted at the necessity of re-vaccination. How a minority of perhaps 25 per cent—to take an outside estimate—could protect the non-vaccinated

majority was never asked. Since those days half a century has passed; vaccination has been made imperative, so that the "unprotected residuum" has shrunk to about 3 per cent. More than this: re-vaccination at adolescence is now insisted upon. This was the case in Prussia as early as 1836, as we know from personal experience. But now Dr. Austin Flint, writing in the "North American Review" for June, considers re-vaccination every five years as advisable. What a practical abandonment of Jenner's original doctrine! To return: in spite of this extended and repeated protection smallpox is openly and palpably more frequent now than it was in the earlier part of the century. Epidemic follows epidemic in quick succession, each, apparently, more rampant and more fatal than its predecessor. Thus the deaths from smallpox in London are given as—

1851—60	7150
1861—70	8347
1871—80	15543

Each decennium thus far appears worse than the one foregoing. What is still more striking, the smallpox extends to an ever-increasing proportion of those who have been duly vaccinated. Thus the official "Report of the Smallpox and Vaccination Hospital for 1866," as quoted by Mr. Taylor, makes the following alarming confessions:—"The ratio of vaccinated cases to the whole admissions of smallpox patients has gone on progressively increasing; thus—

Sixteen years ending 1851 ...	53·0	per cent.
Epidemic, 1851—2	66·7	,,
,, 1854—6	71·0	,,
,, 1859—60	78·0	,,
Years ending 1866	81·0	,, "

Dr. O. Cameron, M.P., whom Mr. Taylor calls "the recognised champion of vaccination in the House of Commons," states, in his article in the "Fortnightly," that the number of smallpox cases per million of vaccinated persons is greater now than in the beginning of the century, and that the death-rate in cases of smallpox after vaccination has risen from 1·75 per cent in 1819 to 9·2 per cent in the years 1870 to 1879, the increase of mortality being *most remarkable* in the *best vaccinated* class of cases.

The "Lancet" (June 18th, 1881) accepts "the recent smallpox epidemic in London, so far as regards the death of

children, as evidence of the failure of the vaccination system as at present carried out."

What do these facts mean? Mr. P. A. Taylor, if we do not misconstrue him, cuts the knot by declaring that vaccination never was a real factor in the question at all,—that its apparent success at the beginning of the century was due merely to its introduction coinciding with a temporary lull in the disease. Since then successive waves of the epidemic, more and more severe, have swept over us, and the impotence of the safeguard becomes each time more and more manifest.

Dr. Cameron, as we think, more impartially holds that vaccination had, and still has, a certain power, which, however, is gradually declining, owing to the transmission of the lymph through such multitudes of human systems. This degeneration, joined to a temporary exacerbation of the character of the disease, may well account for the present lamentable results. The saving-clause of the "Lancet"—"as at present carried out"—admits of more than one interpretation. It may amount to a charge of negligence brought against the surgeons who perform the operation. It may imply the notion conveyed in Dr. Carpenter's sixth proposition, that vaccine protection depends upon the number of marks left upon the arm. But this view disagrees with Dr. Cameron's admission, that the increase of the disease had been most striking in the *best* vaccinated class of cases.

A number of hospital reports, quoted by Mr. Taylor, show that the percentage of cases and of deaths bears no ratio to the number of marks traceable on the arm. Thus the "Report of the Metropolitan District Asylums" gives a table of deaths of children under five years old from small-pox. Of those which had been vaccinated at all the percentages were—

One mark	22	per cent.
Two marks	28	,,
Three marks	18	,,
Four marks	0	,,
Five marks	16	,,

A similar table for persons between thirty and forty years of age runs thus:—

One mark	16	per cent.
Two marks	20	,,
Three marks	21	,,
Four marks	23	,,
Five marks	8	,,

We think no causal relation whatever can be deduced from a discussion of these tables.

But if the failure of "the vaccination system, as at present carried out," is due to a deterioration in the quality of the vaccine lymph employed, the question occurs how and whence is a better supply to be obtained? Here there is, unfortunately, a want of unanimity among high professional authorities. Dr. Carpenter recommends "calf-vaccination." Jenner maintained that so-called spontaneous cow-pox does not protect against smallpox. Prof. Symonds, of the Royal Veterinary College, as quoted by Mr. Taylor, does not believe that any form of variola belongs to horned cattle. We may first inoculate a heifer with smallpox, and apply the matter thus obtained to human subjects. But the result, according to some physicians, is merely a "mitigated smallpox." We find ourselves thus led to Dr. Carpenter's eighth proposition, in which he makes light of the practical danger of the communication of other diseases, especially syphilis and scrofula, by the transfer of vaccine matter from one person to another. This is in reality the turning-point of the whole dispute. If such danger exists, and if it cannot by any precaution be removed, the protest against compulsory vaccination is—to use the mildest expression—perfectly justifiable. It is surely far better that a child should die of smallpox than live as a scrofulous or a syphilitic subject, and in all probability communicate these horrible diseases to others. Now the medical opinions and the professional evidence quoted in Mr. Taylor's pamphlet are by no means reassuring. Sir Thomas Watson, referring to this danger, speaks of vaccination as involving a "ghastly risk." M. Ricard, though a supporter of vaccination, admits that it must be abandoned *if but one case of the inoculation of syphilis could be traced.* Dr. Warlomont says—"In any country where it is obligatory upon parents to have their children vaccinated, the State is under a moral obligation to furnish families with a vaccine which is beyond the risk of all suspicion. Mr. Brudenell Carter ("Medical Examiner," May 24th, 1877) thinks that "syphilitic contamination of vaccine lymph is by no means an unusual occurrence," and further, that "a very large proportion of the cases of apparently inherited syphilis are in reality vaccinal." Mr. Hutchinson pronounces the danger of transmitting syphilis "real and very important." Dr. Ballard, a medical officer of the Local Government Board, writes in a prize essay that "there are numerous cases on record to prove that the vaccine virus and the syphilitic virus may be introduced at the same spot, by the same puncture of the

vaccinating lancet." Dr. Cameron, in a letter to the "Times," states that in 1867 the chief of the French National Vaccination Service published an account of upwards of 160 cases of syphilitic infection, through vaccination, which had been brought under his notice in little over a year."

A Parliamentary Return shows that whilst general infant mortality has been decreasing, the deaths from those nine diseases which are capable of being communicated by vaccination have largely increased. Of 2000 deaths registered as due to syphilis in 1874, 1484 (or nearly 75 per cent) were infants under one year of age.

Dr. Carpenter seeks to set these grim facts aside in a manner which we must decline to characterise. He contends that as we do not refuse to drink water because it may contain lead, so we should not refuse to be vaccinated because the lymph may contain the syphilitic virus! He forgets that it is easy to detect lead in water, whilst to discover the presence of syphilitic poison in vaccine is an unsolved problem. Further, not one nor a hundred glasses of plumbiferous water would establish hopeless lead-poisoning, whilst one minute particle of syphilitic virus introduced into the system may defy elimination. Lastly, even a fatal case of lead-poisoning is of much less consequence to society than a case of the transmission of syphilis. The former evil cannot be communicated by the victim to others. Nor must it be forgotten how greatly the danger is multiplied by the modern plan of repeated vaccination.

If we reject human lymph—a precaution especially requisite in a country like Britain, where syphilis has been in a manner cherished as a moral agent—we encounter, it would seem, other dangers on the nature and probability of which further information is needed. Mr. Taylor contends that vaccination direct from the calf may convey bovine tuberculosis, and that matter obtained directly or indirectly from the horse may implant glanders—an evil worse, if possible, than syphilis itself.

We are now in a position to summarise what has been said. Both Mr. Taylor and Dr. Cameron agree that vaccination, as now performed, falls very far short of giving complete protection, and that such protection is gradually decreasing. But Mr. Taylor goes much further: he pronounces vaccination a "rite," a "superstition," whose "failure begins from its earliest institution." This extreme view he does not prove, and, making all allowance for a temporary abatement of the virulence of smallpox at the

beginning of the century, it is difficult to see how vaccination could have acquired its hold upon the faculty without a solid basis of results. Even in the present day facts favourable to the "rite" are not wanting.

But on the ground of the possible introduction of scrofula, syphilis, &c., we are compelled to admit that Mr. P. A. Taylor has made out a case, if not for the abolition of "compulsion," at least for a broader and more thorough inquiry than the question has yet received. In a matter of so much importance we cannot afford to remain in the dark.

IV. ASTRONOMICAL NOTES.

By O. Reichenbach.*

From a Letter to D. P. Todd, Esq.

THE coincidence in longitude between your planet and Prof. Forbes's inner planet appears "remarkable." Yet it must be as accidental as the approximate coincidence between the longitudes of Prof. Forbes's two planets and my A and B, because the differences in distance are too great.

The coincidence between your planet and my A, on the contrary, presents a considerable probability for the existence of both A and B, and for the more or less correctness of their present positions, because $a=46$ or 52 as you take it, and $a=42$ as I made it twenty-four years ago, differ comparatively little, and because our findings rest on similar bases, the influences of planet upon planet, and are not remotely as speculative as the assumptions of Professor Forbes.

You say there was a conjunction between Uranus and A, as I call it, in 1780 to 1793, and will be another before the close of the century. If A is at present in 196°, there was such conjunction in 1778, and will be another in 1904; if it be in 201°, it was in 1780. You get longitude 170° or less, I 196° or more: that you finally take $a=52$, and I have $a=42$, explains all differences in time of conjunction and present longitude; we completely agree when we both

take 42. I said in 1875 B is in 305° with error in more, say 308°; its distance is 76, not 300 as Prof. Forbes has it: there would have been a conjunction with Uranus between 1824 and 1829, it being at the time in opposition. When you examine the "residuals" in your article you will find this conjunction well indicated, principally when you adopt the names I got for A and B in my development theory in 1857.

In the papers Le Verrier read before the French Academy in 1846 ("Connaissance du Temps," 1849, p. 240) he said—"Erreur presque toujours la même entre 1824 et 27." "Valeur la plus précise 36·154 ne peut varier qu'entre les limites 35·04 et 37·90." "207 a 233 années envirez."

In 1857 I got for Neptune mass 1-14446, pretty near that made out by the two I have; and I believe I can show why the figures since obtained by Prof. Newcomb—the one by Uranus, the other by a satellite—are more at fault.

From a Letter to Prof. GEORGE FORBES.

Is the grouping of comets always determined by one planet only? Are the distances of the two planets inferred from the mean distances of the groupings the true ones? Does not your cometary method give too free play to the hypothesis because the number of periods elapsed since the catastrophe is selective? On the other hand, is it not too great a restriction to require such close coincidence in longitude, and to require that the determining planet should always have been the one having its orbit next to the present aphelion of the comet? Might it not have been the one which was next to that aphelion position at the time of the catastrophe, when the planet with the nearest orbit was far away?

Some comets may have been born within our system; others may enter and leave it; still others may continue in it, and may get condensed, or divided and absorbed.

The incorporation of the comet is the result of the reduction by additional planetary attraction of an original surplus of helio-centrifugality, which carried the comet from another system into ours, and would carry it out again without this disturbance.

We may consider some aphelia of the Jupiter group as originally produced by the inner planets and determined by Jupiter, but all crowded round the greatest of planets.

Between Saturn and Uranus there is no whole group of cometary aphelia, but probably a cluster of smallest planetoids

between Saturn and Uranus. The six comets of the "Neptune group" have their aphelia beyond that planet inside 35 "Earth's radii," inside the first half of the distance from Neptune towards A, at distance 42.

Comets 1857 IV. to 1855 II. all have their aphelia near and somewhat beyond 76 "Earth's radii," the distance I got for B, to which I assigned a considerable eccentricity.

The position of B comes next to that distance which you give to your inner planet. Most of the aphelia of this group exceed $a = 76$ for B in like proportion, as the aphelia of the first group exceed $a = 30$ for Neptune.

The group from 285 to 420 "Earth's radii" is the reason that you place a second planet at 300 such radii: 242 "Earth's radii" equal 524,282, or solar radii fall some distance inside 300 such radii, and play, in my development theory of the solar system, a prominent part.

The last comet on the list, at $a = 4275$, falls little inside I C, the radius of 9,248,007 of the *motion volume* of the solar system.

To show that your method may also work in favour of the distances and positions I obtained for A and B, I take the Neptunian group, because that planet is known, and because A at 42 corresponds to your planet placed by hypothesis at 100, whose position you consider best established.

The group lays entirely within the first half of the proportionally next great distance between Neptune and A, which I took to be at present at 201° with error in less. You mention a star observed in 1860: supposing it was A, it would be now about 196°. I take this instead of 201°.

Of Comet I., 1852, iv., you say "It does not seem to fit in" with Neptune. Its aphelion falls in 215°. At the time of the passage in 1607, A was at 202°.

Comet III., 1815, has its aphelion in 321°; it passed it in 1500, 1570, 1640, and 1710. In 1500 Neptune was in 296°, and in 1710 A was in 335°.

Comet II., 1812, is said to have passed its aphelion in 1635 in 256°; Neptune was then in 242°, and A in 245°.

Comet IV., 1846, iv., and V., 1847, v., of which the aphelia in 260° about coincided in 1810 with the longitude of Neptune, had the nearest coincidence with A in 1666 and 1660 respectively, at 20° and 12° difference.

It is characteristic for cometary changes that I. 1852, iv., of which you say "it does not fit in" with Neptune, but fits so well with A, has its aphelion nearest to Neptune within the group; and that the two last comets, which in their last revolution do not fit with A, but so well with

Neptune, are the nearest to A, about half-way between the two planets.

To fix the distance and position of your nearer planet you have a group of seven comets, of which five had their last aphelion within thirty years from each other.

B is at $a=76$. It is inside and next to the planet you assume; it is, I said, in 308° with error in more. You have accommodated your distances to the requirements of your hypothesis; I have obtained my distances on other grounds, and see when and where the comets meet my planets as nearly as possible, in not too remote periods.

For I., 1840, iv., you carry the catastrophe back to 968. There was an aphelion passage in 1668 in 220°: this would correspond to B at present not in 308°, but in 335°; or at present in 308°, and in 1668 in 193°.

Of III., 1846, vii., and V., 1793, ii., you say they do not "fairly fit in." The first of these comets has its aphelion in 340°; you carry the catastrophe back to 1248, with the planet in 320°. Taking B now in 308°, it would have been in 1248 at 325°. The second comet passed its aphelion in 241° in 1160; B was then in 276°, if it be now in 308°.

II., 1843, i. does not fit in with B, and you refer it to a planet at $a=100$, which was in 98° when the comet was in its aphelion in 100°, in 1655. In the period of 1250 A was in 100°.

IV., 1861, i., aphelion longitude 37° coincidence with your planet in 409; A was in the period of 1239 in 85°.

VI., 1861, ii., aphelion in 96°, coincided with your planet in 1651. In the period of 1232 A was in 76°.

VII., 1855, ii., aphelion in 79°, met your planet in 1609, in 82°; agrees neither with B nor A, but Schulze deduced an ellipsis with an aphelion distance of 57 instead of Donati's 124·2.

V. THE PSYCHIC CALENDAR OF CREATION.*

UNDER this remarkable title Prof. H. A. Reid, Secretary of the State Academy of Sciences at Des Moines, Iowa, gives an original and interesting classification of the organic world, according to the successive develop-

* Kansas City Review of Science, September, 1881, p. 264.

ment of the organs of sense. The order of the "successional types of animal life" appears to him approximately coincident with the geological order, and both lead up to "the perfect harmonisation of the law and philosophy of Evolution with the grand distinguishing doctrine of the Christian Bible, that there is a 'natural (or carnal) man' and there is a 'spiritual man.'" It is doubtless not unknown to many of our readers that the most eminent American biologists find in the doctrine of Evolution, and in its applications, nothing necessarily incompatible with the general idea of a personal God, and in particular with the Christian revelation. In this respect they differ strikingly from a large section of the German, and even of the English, naturalists, who lean towards the materialistic view of the universe. A further distinction which must not be overlooked is, that in the United States Darwinism pure and simple, as it is commonly but doubtfully called,—*i.e.*, the ascription of the origin of organic species to the fortuitous accumulation of minute variations,—is less widely accepted than in Europe. Very few believers in the transformation of species fail to see that before Natural Selection could be brought into play Variation must have existed.

The former of these characteristic features of American Evolutionism scarcely falls within our usual sphere of discussion, and into the latter we are not about to enter at present. But both of them will serve to explain the position taken by Prof. Reid, This author gives, in illustration of his lectures on "Evolution, Science, and the Bible," a tabular view in which all living beings are divided into seven groups. First and lowest come the *Insentia*, primordial fucoids and vegetation generally, having organic forms, but no motative sensibility.

The next step brings us to the *Unisentia*, *i.e.*, sensitive plants, rhizopods, pseudopods, protoplasm; the eozoon. These beings are said to possess the sense of touch only.

As the third group figure the *Disentia*, to wit protozoa, polyparia, radiates, mollusks, having—according to the author—taste and touch.

Fourthly come the *Trisentia*, *i.e.*, sauroid fishes, crustaceans, trilobites, and worms, having—we are told—sight, taste, and touch.

In the fifth class, or *Quadrisentia*, rank humoid reptiles and palæozoic sea-saurians, endowed with smell, sight, taste, and touch.

Next follow the *Quinsentia*, including brute man, mam-

mals, birds, and aerous reptiles, possessing hearing, smell, sight, taste, and touch.

Lastly come the *Sexasentia*, the "spiritual man" of the Bible, having, in addition to all the former senses, a spiritual sense.

The first remark which will occur to the practical naturalist is, that Prof. Reid has found no place for the most numerous of all the great primary groups of the animal kingdom,—*i.e.*, the insects. That they possess *at least* five senses is indisputable, and there is a possibility that some of them may even have more. Then we note that the Crustaceans are thrust down into the Trisentient group, and declared void of hearing and smell—a very hazardous assumption!

The Mollusca fare still worse, and are pronounced to have taste and touch only. Yet the Cephalopoda, the highest molluscous type, have very distinct eyes, and also organs of hearing.

As unisentient we find "protoplasm" figuring as a distinct animal, or vegetable species. As to the eozoon, its organic character is still *sub judice*, and any expression as to the number of its senses is therefore somewhat indiscreet.

Lastly, it may be question whether vegetation generally should rank lower than the simplest forms of animal life.

We do not dispute, as Paley suggests, that "there may be more and other senses than those which we have." We have speculated on the possibility of such senses, and are even now searching for phenomena which may demonstrate their existence. We would also agree with Prof. Allman that "in the far-off future there may be yet evolved other and higher faculties."

The author advances the opinion that Man is an "embryonic and transitional type," and not a "closed or terminal type like the Quadrumana and other lower forms." It may be noted that there is at least one instance of an animal reproducing itself not in its highest stage, but in an antecedent and inferior condition. We will likewise not forget the fact that the embryonic stages of certain animals remind us of the mature structure of lower types. But let us suppose Prof. Reid to say, if formally challenged to produce scientific evidence, that man is a larval, transitional form. We fear the analogies above mentioned, and others which might be cited, will scarcely be accepted as decisive.

VI. A BRACE OF PARADOXES.

MANY persons at the present day are not only willing, but anxious, to submit their most confirmed practices and their most deeply-rooted convictions to a re-examination. Of this tendency no one can justly complain provided the scrutiny is carefully and seriously undertaken. But it sometimes happens that old customs and established opinions are challenged on the strength of some desultory one-sided observation, or of some hasty and imperfect induction. In such cases the logic of Science bids us pause and most carefully weigh the evidence submitted to us before adopting the novel views. The history of discovery tells us of many undoubted truths which, when first propounded, were met with opposition, ridicule, and even downright persecution. But it can tell us little of the sham facts, of the baseless hypotheses, of the mad philosophies which are continually springing up like toadstools in an autumnal wood. The authors of such phantasies are always ready to pull down and re-erect at brief notice the whole fabric of modern Science; and if learned societies and editors of journals turn a deaf ear to their lucubrations, they pose in the character of a neglected Lamarck or an imprisoned Galileo, and warn us that posterity will do them justice. Britain has been particularly rich in such men. But in this respect, as well as in certain others, we may yet find ourselves outstripped by our kinsmen across the Atlantic.

We propose, in illustration of this subject, to take up two new biological notions, lately put forward in America, the one of a practical and the other of a speculative character, and examine the evidence upon which they are founded. We are far from asserting that the theories in question have been promulgated from the mere love of notoriety, or from dissatisfaction with existing customs and opinions simply as existing. But we think that there has been a great lack of thorough examination and a degree of rashness not entirely free from blame.

The first of these novel doctrines relates to the mastication of food. We have all been told by medical authorities, from Abernethy downwards, that to bolt our food rapidly in large lumps interferes with digestion, throws upon the stomach an additional burden, and thus injures health. This advice, be it remembered, was not founded upon

chemico-physiological investigations, but upon experience and observation. Theories concerning the action of the saliva, and anent comminution as exposing a larger surface to the action of the digestive fluids, were added subsequently in explanation. Further, if food is to be bolted, not chewed, what is the particular necessity for teeth and for saliva at all?

It must also be considered that whether we owe our teeth to an act of special creation or to the development worked out under the influence of natural selection, the case will be the same. Yet, in face of these considerations, deliberate feeding and thorough mastication are now condemned as not only needless, but positively hurtful, interfering with the work done in the stomach instead of promoting it. Dr. W. Browning, in order to decide the question, made a series of experiment upon dogs, and says:—" If the meat, before being fed to the dog, was reduced to hash or cut into fine pieces, the digestion was at best but imperfect, a considerable portion of the undigested or imperfectly digested meat being found in the excreta. If, under the same conditions, meat was fed to the dog in large pieces, it was bolted at a gulp, with the result that little, if any, passed through undigested: compared with the result from the chopped meat, it could be called a perfect digestion for the coarse form as compared with a decidedly imperfect digestion for the fine form. So far as simple experiment goes, this must be pretty conclusive for the dog."

From these facts he reasons, in our opinion illogically, that the same ought to be true of human digestion. Illogically, we say, because the circumstances of the cases differ in every important particular. Meat, the main diet of the dog, as of all Carnivora, is admittedly easier of digestion than other articles of food. Hence we see that the teeth of the Carnivora are adapted not for mincing and grinding, but simply for cutting and tearing flesh into morsels not too large to be swallowed. The more exclusively and truly carnivorous any animal, the more its teeth display this type, whilst in proportion as any species inclines to a mixed diet the more its teeth are fitted for grinding. If we, then, mince the food of a carnivorous animal we place it under abnormal circumstances, and must not wonder if its functions are disturbed. With man the case is very different; his food is more or less composed of vegetable matter; his teeth are adapted for grinding to a pulp, and his intestines are relatively larger than those of the dog. If we may logically argue from the dog to the man, why not also to the

horse, and even the cow? Shall we tell the former that careful grinding and the latter that rumination are respectively mistakes?

Prof. Ludwig, it seems, has made some experiments upon himself to test this theory, eating coarsely-cut meat at one time, and at another meat finely divided. He reports that he "has not been able to detect any evil consequences from swallowing mouthfuls as large as he could get down." We dare say not; he has, in the first place, experimented with meat, the most digestible of foods, and the one which does not require the action of the saliva. Let him try with bread, potato, lentils, carrots, &c., bolting them in the lump. It is not stated, further, how long his experiments have been continued. The results of an unwholesome way of living often do not make themselves felt for years.

We have never purposely made any experiments with reference to this question, but we have often noticed that after a hurried meal oppression of the stomach and other symptoms of indigestion made themselves felt. Often have we heard from acquaintances similar complaints of the action of food swallowed in haste, and without due mastication.

Dr. J. F. Hibberd, quoted in the "Boston Journal of Chemistry," says that healthy people generally eat fast, while those that are unhealthy eat slow. Were this rule general, which we are far from admitting, it would bear a very different interpretation from that which he seems to suggest. Healthy people, especially when young, often take liberties with their constitutions which the feeble and sickly cannot venture upon, whilst the unhealthy have often learnt by sad experience to avoid unwholesome practices. Suppose we were to say "People with sound strong teeth generally bite string and thread, straighten pins, and crack nuts with the mouth, whilst those with decayed and loose teeth do nothing of the sort." Would it be logical to argue that the nut-cracking and thread-biting were the causes of the good teeth of the former? Yet this is exactly Dr. Hibberd's style of reasoning. Speaking of teeth we are reminded that, if the new theory is well founded, their day—be they natural or artificial—is over. Wherefore let the dentists look well to the matter.

The second paradox which we shall notice was brought forward at the Cincinnati meeting of the American Association for the Advancement of Science, by Dr. C. S. Minot, of Harvard University. He read a paper entitled, "Is Man the Highest Animal?" and answered his question in the nega-

tive! Now many of our readers are doubtless aware that scientific notions concerning the relative rank of different forms in the animal kingdom are at present in a very unsettled condition. The old view that animals rise successively higher and higher as they approach nearer and nearer to man has been challenged in several quarters. It is inconvenient for those who wish to establish a want of continuity between man and the rest of the animal kingdom. Thus an eminent biologist who maintains this view, pronounces the cats "the very flower and culmination of the Mammalian animal tree," and declares that man, "considered merely in his capacity as an animal, has a very definite place in such a scheme, but it is by no means certain that his place is at its summit;" and again, "the close bodily resemblance of the apes to man gives them no just claim to a rank above that of the Carnivora, since such a claim only reposes on their bodily resemblance to ourselves." Thus Professor Minot is not entirely taking a new departure. He maintains that the measure of biological rank is the degree of specialization exhibited by all the organs, taken collectively. The measure of specialization he finds in embryology, "which shows in earlier stages simplicity and uniformity of structure, which in later stages is replaced by complexity." We quote here the author's own words because we shall have shortly to turn them against himself. He declares that "specialization may be exaggerated in one or several organs without the animal attaining a high rank as a whole, and this he pronounces to be the case in man. In the human body he admits certain high differentiations. to wit, "in the brain, in the changes induced by, or accompanying, the upright position, and in the opposability of the thumbs to the fingers." In these points he admits man to be "more highly specialized than any other animal."

On the other hand he finds in man, "instances of a still more striking inferiority." His senses are less acute than those of many animals; "he has neither the keen vision of the falcon nor the delicate scent of the dog." On this we may remark that though the sight of birds of prey is telescopic, yet that in them nice discrimination of colour is not proven. Man cannot have so acute a scent as the dog, because the development of the brain leaves little room for the olfactory lobe. Prof. Minot goes on to assert that man's teeth are of a "low mammalian type," and that "similar inferiority is shown by his limbs, since they are little modified from the primitive (embryonic) form, preserving the full number of five digits. In respect of these members

man stands, therefore, very low—lower than the cow and the pig."

We must here point out that a departure from the original embryonic type may be in one of two directions; it may be progressive, passing, as the author has above laid down, to greater complexity, or it may be retrogressive or degenerative, tending towards less complexity. All the modifications of the limbs which reduce the number of digits are, therefore, cases of degeneration, and the author, in pronouncing man's five fingers or toes a mark of inferiority to the structure of the cow or the pig, contradicts what he has advanced above. Again, he has admitted the "opposability of the thumbs" as a mark of high specialization. In afterwards ascribing superiority to an extremity where the digits are undifferentiated, and reduced to two or to one in number, he is guilty of a second contradiction.

Again, in the ruminants, &c., the four extremities are scarcely at all differentiated in structure or function. They are mere supports, adapted for locomotion. As we pass through the Carnivora and the apes to man, we find the two pairs of extremities more and more differentiated—a familiar instance of man's superiority which the author has ignored.

Again, we read that man "plants the whole sole of his foot upon the ground, yet none but the lower Mammalia, together with man and his immediate congeners (a formidable exception!) are plantigrade." Now if man is to stand on two extremities only, which Prof. Minot has just mentioned as a mark of high specialisation, he must be plantigrade! Here, therefore, is a further case of self-contradiction.

The author proceeds, "So, too, with his stomach, which is so simple as compared with that of a ruminant, and, indeed, is of about the same grade as that of the Carnivora." Surely the stomach of the ruminants is a mere adaptive feature suitable for animals which require to consume a huge bulk of matter poor in nourishment. But it is important to see how Mr. Minot plays fast and loose. In case of the foot and hand he proclaims complexity a mark of inferiority. In the stomach he holds it to be a sign of superiority! He is consistent only in inconsistency and self-contradiction.

Further; "It makes a still more forcible impression to learn that the human face which we admire when withdrawn under a high intellectual forehead, is perhaps the most remarkable of all the indices that point to man's inferiority. In the mammalian embryo the face is formed under the

forebrain; in our faces the fœtal disposition is retained with changes which, when greatest, are inconsiderable. In quadrupeds the facial regions acquire a prominent development, leading to the specialization of the jaws and surrounding parts, which brings the face to a condition much higher than that of the fœtus. Hence the projecting snout is a higher structure than the retreating human face."

If this doctrine holds good it must avail within the human species, and hence prognathous races will be entitled to rank higher than normal man. But how is the prognathous type acquired? Banish a tribe to some unhealthy climate and feed them on insufficient and unwholesome food, and they will become prognathous, and at the same time stunted. Perhaps Prof. Minot would pronounce them higher than their ancestors.

The author might have done well to remember that snoutiness—if we may use the term—reaches its height in certain groups which must certainly rank among the lowest mammals, *e.g.*, the Insectivora, the Edentata, the Platypus, Echidna, &c. Yet on his showing this feature ought to be a mark of superiority.

The author's great error lies in the tacit assumption that every departure from the original embryonic type is progressive, whilst both in the individual and in the animal series it is very frequently a case of degeneration.

What animal he considers entitled to the highest rank he prudently declines to state. He adds further, "It is also doubtful whether mammals would be regarded as the highest class of the animal kingdom, were they not our nearest relatives." Here, again, he would have done well to say to what class he would assign that honour.

We refer with regret to the strong language which Prof. Minot has thought it becoming to apply to those who differ from him. The ordinary view he pronounces "a silly prejudice of arrogant ignorance." This comes with scant grace from a man who cannot reason without contradicting himself at every turn, and who in addition has not proved his superiority to the bulk of mankind by any discovery of capital moment. The future of the New Natural History will be gravely compromised by such speculations.

VII. TRICHINÆ AND THEIR DISTRIBUTION.*

FLESH-WORMS are now fully recognised as one of the most decided scourges of the human race, and a war of extermination has to be waged against them. It must not be supposed that these *Trichinæ* are a newly-created pest, or that their habits have even undergone any decided modification within historical ages. In the days when the microscope was not, the presence of these parasites in pork and other flesh was little likely to be noticed, and when medical science was in its infancy the symptoms of trichinosis might very well be confounded with those of typhoid, of malarial fever, or of acute rheumatism. Dr. Leidy thinks that, even as recently as the American civil war, numbers of deaths in reality due to the use of semi-cooked pork were ascribed to fevers.

Passing over, as beside our present purpose, the life-history of the parasite, its detection in meat, and the means recommended for its destruction if so present, we turn to the agencies for its distribution from one individual or one species to another. *Trichinæ* may be present, it appears, in swine, dogs, cats, rats, and incidentally in oxen, rabbits, and guinea-pigs. According to Mr. Phin birds and sheep do not offer an acceptable harbour to these intruders, since, even if fed upon trichinised matter, the parasites have not been detected in their flesh. We have heard, however, that certain French soldiers became fatally trichinised from partaking of the flesh of a goose. As the goose does not feed upon carrion, or offal of any kind, this case, if authentic, is the more serious. Trichinised river fishes are also said to have been detected near Antwerp.

Mr. Phin enumerates four methods in which *Trichinæ* may be conveyed from one animal to another. The general process is that the trichinised animal is eaten, wholly or in part, by some carnivorous or omnivorous creature. In this manner man, swine, rats, cats, and dogs most frequently become infected. Man is exposed to this danger only when he adopts the custom of eating pork, &c., raw, or "rare," which is the fashionable euphemism for half-raw. Among

* Trichinæ, How to Detect them and How to Avoid them. By JOHN PHIN Rochester (U. S.): Bausch and Lomb. Co.

swine the infection has become greatly increased since the abominable practice of feeding them upon butchers' offal became general; and it is remarked that the very parts given to pigs—such as the diaphragm, and the junctions of muscles and tendons—are exceedingly liable to contain *Trichinæ*. But we must beware of supposing that swine fed upon corn, fruits, mast, &c., must necessarily escape the pest. A wild boar killed in November last, near Khiam, in Syria, according to the "Lancet," communicated trichinosis to two hundred and sixty-two persons, several of whom died. It appears that the wild boar, when grubbing in the earth for roots, frequently snaps up and devours rats, field-mice, &c. The habits of tame and half-wild swine, when turned out into the forests, are precisely similar. Even when in the sty, pigs have been known to capture and devour the rats which came to steal their food. It often happens, also, that rats which have been worried by dogs—who rarely, if ever, eat them—are left in the way of pigs, and get eaten. Dogs are much given to prey upon slaughter-house offal, yet are seldom found trichinised. Mr. Phin has never met with an authenticated instance. Cats, on the other hand, according to Dr. Seiler, of Philadelphia, are very frequently infected. Mr. Phin considers that the cause of this lies in the fact that cats eat rats, while dogs never eat them. We can scarcely accept this contention. We have known cats who were adepts at ratting, but who never devoured their prey. Others, if very hungry, will eat the liver, and sometimes the back of the neck, which it must be admitted is a very likely habitat for *Trichinæ*. Cats, however, according to Dr. T. Spencer Cobbold, F.R.S., are exceedingly subject to parasites.* Rats which prey upon slaughter-house offal are often trichinised. Pikes may conceivably become trichinised by devouring rats in the rivers.

The question may here be raised, What animal is the original *nidus* of the *Trichina?* At present we see the pig receiving them from the rat, and the rat again becoming infected by devouring pork. But we are unable to lay our finger on the beginning of the series.

A second source of infection must be sought in the excrements of animals which have recently become infested with *Trichinæ*. Mr. Phin observes that the pig, the rat, and the dog "are all ravenously fond of excrementitious matter, eating it greedily when they can get at it." So, we may

* Internal Parasites of our Domesticated Animals, p. 124.

add, are domestic poultry, as well as slugs and snails. When any animal has recently been feeding on trichinised matter its excrements will contain young *Trichinæ*, and even mature females who have not yet brought forth their progeny. In this manner, among dung-eating species, one individual may affect the herd. Even animals not intentionally and consciously devourers of excrement may contract trichinosis if the fæces of rats or mice are mingled with their food or drink. Mr. Phin suggests that the hippopotamus which died some time ago at the Zoological Gardens may have become infested with *Trichinæ*.

A third manner in which these intruders may be spread from animal to animal, if less frequent in its occurrence, is more insidious, and may reach creatures which eschew impure food. Let us take the very possible case that a trichinised dog, cat, or rat, is drowned in a pond or river, or that its carcase is thrown into the water in that nasty spirit which dooms our streams to be the common repositories for filth. The body putrefies, and the *Trichinæ* present in its intestines, or encysted in its flesh, are set at liberty. Will they not be destroyed by the process of putrefaction? No; unfortunately, like most nuisances, vegetable or animal (human included), they are very tenacious of life. They have been experimentally kept for months in putrefying animal matter without apparent injury. If, therefore, a cow or a horse happens to drink the water near the place, it may receive into its stomach a number of *Trichinæ*. Now to prevent dogs, cats, and rats from being occasionally drowned in our rivers is a consummation devoutly to be wished for, but we fear beyond the power of the most stringent legislation.

So far as we have gone the vegetarians may tell us that if we suffer from trichinosis we are justly punished for eating "impure" food. But their turn is now to come. Even vegetables may be contaminated. If plants are manured with the offal or the excrements of trichinised animals, they may communicate the infection. For man the chief danger is in case of lettuce, celery, radishes, and herbs eaten raw.

Bearing in mind the facts that *Trichinæ* are not in any moderate lapse of time destroyed by contact with putrefying animal matter, fæces, &c., and that they can bear prolonged immersion in water without injury, we may well assume that they will occasionally be present in sewage. Pigsties, slaughter-houses, &c., will occasionally be washed down into the sewers; they may happen to contain *Trichinæ*. Let us now suppose that such sewage is used for irrigation, and is

turned over pastures or market-gardens, as at Gennevilliers. It is perfectly possible that man and herbivorous animals may in this manner receive the infection.

It is interesting to notice the very illogical manner in which irrigationists have sought to disprove the danger of the transfer of *Trichinæ*, and of Entozoa in general, through the agency of their favourite scheme. They have, forsooth, fattened an ox upon sewage-grown vegetables, and have then submitted the carcase for microscopic examination to competent authorities; and no signs of the presence of internal parasites having been discovered, they have ventured to proclaim the danger entirely imaginary! But no one has asserted that *every* sewage-irrigation field must *at all times* receive Entozoa or their germs, and that *every* animal fed upon the produce of such fields must be infected. There is merely the great probability that such may be occasionally the case, and in virtue of the very serious character of the consequences our only safe course is to treat all sewage-grown vegetables, and all animals fed upon such vegetables, as suspicious. A man adopting the irrigationist logic might say "I have eaten a slice of raw ham, or a raw sausage, or an underdone pork-chop, and have suffered no injury: therefore *Trichinæ*, if they exist at all, are harmless!" So long as we know that Entozoa can, and actually do, exist in sewage, so long we are warranted in protesting against its direct application to crops which are to be eaten in an uncooked state, either by man or beast.

It must of course be admitted that the number of *Trichinæ* which may be introduced into an ox by a draught of infected water or a feed upon contaminated grass, clover, or cabbages, or into a man through the medium of a salad or a stick of celery, is very small. But unhappily the pest is rapidly prolific. Each female brings forth about 10,000 young, and if we assume that half the adult *Trichinæ* are males, and that a considerable proportion are expelled from the body of their host, along with the excrements, before they have time to bore their way through his stomach and bowels and enter his muscles, we may assume, with Dr. Cobbold, an average progeny of 3000 for each *Trichina* swallowed. Phin, for argument's sake, takes only half this number, and calculates accordingly that if a rat, feeding on butchers' offal, swallows two dozen *Trichinæ*, it will shortly have 36,000 of their progeny encysted in its muscles. Suppose the rat to be in due course devoured by a porker, the latter will speedily contain a population of some fifty millions, and its flesh, if eaten by human beings in doses of (say) half a

pound, without thorough cooking, may bring on fatal attacks of trichinosis. Thus the rat, so to speak, condenses and concentrates the mischief.

There are certain modern changes in our habits which are very favourable to the spread of Entozoa in general, and of *Trichinæ* in particular. Imperfect cookery has, indeed, always ranked among our national sins, and we still cling to the semi-barbarous habit of submitting our animal food to the action of fire in such large masses that the heat cannot penetrate to the centre of such sparingly-conductive matter. But in former days we were always, as far as the present writer has been able to learn, much more careful about the thorough cooking of pork than of beef or mutton. Latterly, however, we seem to have caught the German superstition that smoking meat may be accepted as a substitute for cooking. We do not believe that Englishmen have yet been persuaded to eat raw ham, "hack-fleisch" (*i.e.*, raw meat), minced or "speck-salat,"—to wit, salads in which bits of raw bacon do duty instead of oil. But we fear that smoked (and uncooked) sausages are gradually finding their way into consumption. Parenthetically we may point it out as something exceptional that we, who as a nation are very conservative in our diet, should have been so quickly taught to relish the flavour of burnt wood.

Some people have come to believe that the operations of salting and smoking may kill the *Trichinæ*. As far as the surface of a ham is concerned this may be the case. But the quantity of salt and smoke necessary to penetrate the centre of a thick piece of meat, and destroy the *Trichinæ* right through, would be more than sufficient to make it indigestible, and indeed quite uneatable.

The action of fire itself, as commonly applied, is not sufficiently prolonged to destroy life to the very centre. As Mr. Phin remarks, "the cooking must be *thorough;* no mere surface-scorching, on the one hand, or brief dipping in boiling water, on the other." A temperature of at least 160° F.—we should say rather 212° F.—must be reached in every part of the meat. It is, indeed, maintained that so long as any part when cut looks red, or emits a red juice, so long there is no safety,—a result manifestly unattainable if the meat is cooked in large masses. It is exceedingly unfortunate that in these days such a great proportion of the population are compelled to dine at eating-houses, or to buy their food at "ham and beef shops," in both which classes of establishments semi-rawness is the rule.

On the prevention of *Trichinæ* Mr. Phin has various

suggestions to make, which if followed out would certainly lessen the evil. He would prohibit feeding pigs on raw offal of any description. "All animal matter fed to pigs must be chopped into pieces not larger than a cubic inch, and thoroughly cooked." This process, he considers, would not only destroy the parasites, but so improve the food that the extra expense would be more than made up.

This recommendation is right to a certain extent, but we should propose a more decisive step, *viz.*, the total prohibition of animal offal, blood, &c., being used for feeding swine, or any other beast consumed as human food.

Secondly, Mr. Phin would forbid the use of slaughter-house manure or offal on pastures or "land on which are grown vegetables to be eaten in a raw state by man or beast." This prohibition must, by a parity of reasoning, be applied to sewage. The use of blood, offal, &c., might be rendered perfectly safe by a process of torrefaction at about 250°. At this temperature no valuable principle is driven off, and, according to the experience of certain French authorities, animal matter thus treated is more available as plant-food, whilst all Entozoa would certainly be destroyed. The slaughter-house refuse at present given to swine would find a useful application as manure after being submitted to this process.

Sewage-irrigation would of course be very much restricted in its applications, but manures obtained by precipitation would be freed from *Trichinæ* and other Entozoa by the temperature employed in drying the deposit.

Mr. Phin's pamphlet may be regarded as exceedingly timely in giving, in a condensed and intelligible form, correct information on a newly-recognised danger.

ANALYSES OF BOOKS.

The Formation of Vegetable Mould through the Action of Earth-Worms, with Observations on their Habits. By Charles Darwin, LL.D., F.R.S. London: John Murray.

Many persons will probably consider the work before us un-Darwinian. It contains, indeed, no reference to the origin or the transformation of organic species, or to the theory with which the name of our great English naturalist will be for ever connected. But it is characteristically Darwinian as summing up the effects of a continually recurrent cause, each of whose manifestations may be feeble, whilst their total result is mighty. The ability thus to trace the working of agencies is one of the most prominent features of the author's mind. Another characteristic of the writer is the patience and perseverance with which, in this as well as in his other researches, his ideas are elaborated and tested prior to final publication. More than forty years ago Mr. Darwin read before the Geological Society a short paper on the formation of the so-called vegetable mould. He referred to the fact that ashes, burnt marl, &c., which have been spread over the surface of meadows, gradually disappear from view, and in the course of a few years may be found in a layer at the depth of some inches beneath the turf. This phenomenon, which farmers often ascribe to some "kind of alacrity in sinking" possessed by bones, marl, lime, and other materials spread upon the land, was traced by the author, at the suggestion of his friend Mr. Wedgwood, to the agency of earth-worms. The theory was opposed by M. d'Archiac, Mr. Fish, and others; but Mr. Darwin has not merely fully proved it by a series of prolonged and careful measurements, in which his sons and several of his friends have taken a part, but he has further shown that these humble creatures are geological agents of no small importance, aiding in the disintegration of rocks, in the denudation of the land, as well as in the preparation of the soil for the growth of plants.

The inquiry necessarily involved a careful examination of the habits, powers, and faculties of the earth-worm. Everyone knows that this little animal lives in tubular burrows in the earth, which it rarely leaves except before evening; that it travels in the night, especially in damp, rainy weather, leaving long tracks in the mud and sand. Everyone must also have noticed their so-called "castings,"—small heaps of earth which they bring up to the surface of lawns, meadows, &c. The worm in making its burrows pushes the soil partly aside, and eats the

rest. All animal and vegetable matter which is in a suitable condition is digested and assimilated, whilst the residue, very finely divided, is ejected in the form of little globular pellets. With this matter they line the walls of their burrows, but much of it they bring to the surface. The weight of each casting is not very great; but in order to estimate rightly what worms can do, we must, following Mr. Darwin, consider their number per acre, and form an idea of their work over a long series of years. Prof. Hensen, in a treatise on the habits of worms, calculates, from the number which he found in a measured plot of land, that there must be upwards of 53,000 worms per acre, or, taking their average weight at 15 grains each, about 356 lbs. Mr. Darwin found in a single cake of earth, of the size of two open hands, seven worm-burrows, of the diameter of goose-quills.

A gentleman, mentioned by Mr. Dancer in the "Proceedings of the Manchester Philosophical Society," having upset some barrels of sour ale on his land, was amazed at the heaps of worms which lay dead on the surface. We have often noticed the multitudes of worms which fall into small water-courses cut in grass-lands for irrigatory purposes. If we also remember to what extent they are devoured by moles, birds, hedgehogs, slugs, and other enemies, without growing scarce, we must admit that their numbers are very great. The weight of the castings found at the mouth of each burrow varies greatly. In the case of our common British worm it is found, by actual collection and weighing, to range from ¾ oz. to close upon 4 ozs. But the author is prepared to give more exact data. A lady friend undertook to collect and preserve for a whole year the total worm-casts thrown up on two separate square yards of ground, near Leith Hill, Surrey. From one of the plots—a place unfavourable for the life of worms—the year's castings, when dry, weighed 3½ lbs. The other plot gave 7¼ lbs. The former consequently would show 7½ tons of dry earth per acre, raised to the surface by the activity of worms, whilst in the latter it would reach 16 tons. At the latter rate the deposit, if uniformly spread over the surface of an acre, would measure in the course of a single year 0·1429 inch, or in round numbers nearly 1½ inches. This quantity is somewhat smaller than the rate at which mould accumulates over objects left on the surface of the ground in a similar time. But Mr. Darwin points out that earth is also raised to the surface by moles, ants, dung-beetles, &c., and that a part of the worm-castings is blown away in dry weather, and washed down in time of rain. Thus we see that in the course of years every particle of the upper soil of a field or garden must have been finely comminuted and passed through the intestines of worms. It is doubtful whether their burrows contribute much to the drainage of the land, as worms generally stop up the opening with leaves, or in default with small stones. But that they admit air, and thus aid in the chemical changes going on in the sub-

soil, there is no doubt. From this point of view it is to be remarked that the contents of the intestines of worms and the castings themselves are always acid. A considerable quantity of dead leaves, &c., are also drawn into the burrows to the depth of 3 to 4 inches, and thus the organic matter in the soil is increased. As regards the acid secreted by worms, or otherwise produced in their systems, we would suggest that it is not improbably the oxalic, a solvent well adapted for effecting the chemical disintegration of many kinds of rocks. Numbers of minute stones are also swallowed, and by the mechanical action of the gizzard and their friction against each other they are in part pulverised.

It will easily be seen that any agency which raises small quantities of earth from beneath to the surface, and deposits them there, must aid in the process known to geologists as denudation. If the surface has a slope, the fine soil thus deposited will gradually be washed down by rains, and must then find its way to the nearest water-course, and ultimately to the sea. In dry weather the castings must be dispersed by the wind, and carried to leeward. Hence the difficulty of believing that "any appreciable quantity of earth can be removed from a gently inclined surface, covered with vegetation and matted with roots," is removed. It may even be suggested that worms play a part in causing large boulders and fragments of rock to travel down gentle declivities. They like the shelter of stones, and by gradually excavating and removing the soil from beneath the margins of the block they may cause it gradually to slide downwards.

It is also by the action of worms that ancient pavements, coins, weapons, &c., left upon the surface of the earth, gradually disappear from view. Mr. Darwin mentions that a footway leading across his lawn, and constructed of flagstones set edgewise, had become covered with an inch of mould between the years 1843 and 1877.

The interesting account of the habits of the earth-worm can be but very briefly noticed. From careful observations and experiments it appears that worms do not possess eyes, but can nevertheless distinguish light from darkness. If brightly illuminated they withdraw, not by a reflex action, but voluntarily. They have no power of hearing, but are very sensitive to vibrations and to changes of temperature. They appear to possess the senses of smell and taste, though very imperfectly developed. Though omnivorous, and even given to cannibalism, they prefer some kinds of food to others. From the experiments of Mr. Darwin, on the manner in which they drag into their burrows leaves of different shapes, they may even be considered as not entirely without intelligence.

We must here close our survey of this work, with which naturalists will do well to make themselves acquainted, both for the facts which it makes known and as a model how researches of this nature ought to be conducted.

On Miracles and Modern Spiritualism. Three Essays. By ALFRED RUSSEL WALLACE. Second Edition. London: Trübner and Co.

THE phenomena commonly known as spiritualistic occupy a most exceptional position. If a man of Science, of well-proved merit, dissatisfied with the vulgar explanations of "jugglery and imposture," ventures to examine the question as he would any other unsolved problem, he is forthwith assailed with the most scandalous misrepresentations. If a reviewer in dealing with a Spiritualist work expounds its tenets fairly and candidly, he too has sinned against those self-constituted authorities who presume to dictate what we are to investigate and what we are to overlook. As perfectly disinterested spectators we cannot but suspect that this evident wish to suppress is the outcome of a fear lest some, at least, of the teachings of Spiritualism should be true. Every man of Science in the present century is—or at least professes himself—ready to submit his most cherished theories to revision. Is then Monism—the doctrine that there exists in this universe naught save matter and motion—so dear to some of us that any testimony which might possibly tell against it must be dismissed unheard? We fear this is in some quarters the prevailing sentiment.

The work before us is one which may demand the serious and respectful attention of the scientific world. Its author is no weak-minded, ignorant fanatic. As the independent co-originator with Darwin of the doctrine of Natural Selection, as the author of "The Malay Archipelago" and the "Geographical Distribution of Animals," he has earned a world-wide reputation. He is everywhere recognised as a careful and accurate observer of facts, and no less as a happy generaliser. His suggestiveness, his power of explaining difficulties, are well known in the scientific world. His early training, as he himself points out in his Preface, was of such a nature that he became a "thorough and confirmed materialist." Further, it cannot be assumed that Mr. Wallace, by coming forward as a believer in Spiritualism had anything to gain. On the contrary, by the part that he has taken he has in some quarters decidedly damaged his reputation. He himself gives us the reason for the striking, though gradual, change in his opinions:—"The facts beat me." His curiosity was excited; his desire for knowledge and love of truth led him on. He strove vainly to account for the phenomena on the known principles of modern Science, and at last by slow degrees he felt compelled to accept the spiritual explanation. Surely after such avowals, coming from such a man, Spiritualism demands a more heedful examination than has been accorded to it by unscrupulous egotists and obscure "exposers," craving for notoriety if even under an *alias*.

A very important question will here suggest itself to biologists —Are the doctrines of Spiritualism compatible with the theory of Evolution? Mr. Wallace upholds the affirmative in a passage which we must take the liberty of quoting in full. He says:— "Having, as above indicated, been led by a strict induction from facts, to a belief,—1stly, in the existence of a number of preter-human intelligences of various grades; and 2ndly, that some of these intelligences, although usually invisible and intangible to us, can and do act on matter and do influence our minds,—I am surely following a strictly logical and scientific course in seeing how far this doctrine will enable us to account for some of those residual phenomena which Natural Selection alone will not explain. In the 10th chapter of my "Contributions to the Theory of Natural Selection" I have pointed out what I consider to be some of these residual phenomena, and I have suggested that they may be due to the action of some of the various intelligences above referred to. This view was, however, put forward with hesitation, and I myself suggested difficulties in the way of its acceptance; but I maintained, and still maintain, that it is one which is logically tenable, and is in no way inconsistent with a thorough acceptance of the grand doctrine of Evolution, through Natural Selection, though implying (as indeed many of the chief supporters of the doctrine admit) that it is not the all-powerful, all-sufficient, and only cause of the development of organic forms." We must venture to suggest to Mr. Wallace the further expansion of this interesting idea.

This reference to the compatibility of Spiritualism with the theory of Evolution reminds us of another point. At Spiritualist *séances* the forms manifested to the spectators are (or are supposed to be) the spirits of human beings exclusively. Now in conversation with Spiritualists we have more than once thrown out a friendly challenge that they should seek to obtain manifestations of pre-human anthropoids, missing links, and other extinct animals. Not being, for the most part, naturalists, they have paid no attention to our suggestion, or have perhaps regarded it as a mere joke. But we maintain that such manifestations would, equally well with the appearance of deceased men and women, prove the existence in living beings of an element not destroyed by death. Further, the ordinary spirit manifestations are open to the objection that the medium or a confederate artfully personates the supposed shade. But it would be impossible for such persons to personate successfully a Pterodactylus, a Hyenodon, or a Pythonomorpha. To naturalists such manifestations would be priceless; they would supply absolute demonstration of the theory of Evolution, and prove the continuity of mankind with the lower animals. Will Spiritualists make the attempt? Having put forth this suggestion it was with much pleasure that we read some remarks by Mr. Gerald Massey ("Light," Oct. 15) to this effect:—"It would be of equal inte-

rest to the evolutionists to know that the Spirit of a monkey persisted (habits and all) as if it had been the Spirit of a man, and it would give me just as much pleasure to learn that our poor relations do continue as if I received a message from some far more highly developed being."

Mr. Wallace's book consists of three distinct treatises:—"An Answer to the Arguments of Hume, Lecky, and others, against Miracles," "The Scientific Aspect of the Supernatural," and "A Defence of Modern Spiritualism."

The first of these essays, which was read eleven years ago before the Dialectical Society, and was printed for private circulation, is, in our opinion, a most complete refutation of Hume's argument. The great Scottish philosopher gives in the outset two definitions of miracles. He says that "a miracle is a violation of the laws of Nature," and again, "A miracle is a transgression of a law of Nature by a particular volition of the Deity, or by the interposition of some invisible agent." Mr. Wallace shows that these definitions are both bad, and that they in fact beg the question by the improper use of the terms "violation" and "transgression." He writes "the first definition assumes that we know all the laws of Nature; that the particular effect could not be produced by some unknown law of Nature overcoming the law we do know: it assumes, also, that if an invisible intelligent being held an apple suspended in the air, that act would violate the law of gravity. The second definition is not precise; it should be 'some invisible intelligent agent,' otherwise the action of galvanism or electricity when these agents were first discovered, and before they were ascertained to form part of the order of Nature, would answer accurately to this definition of a miracle." Mr. Wallace proposes instead the following:—A miracle is "any act or event necessarily implying the existence and agency of superhuman intelligence." He shows further that Hume deliberately and absolutely contradicts himself as to the amount and quality of the testimony in favour of miracles; and he points out the palpable fallacy of the argument, absolutely puerile, that "miracles connected with different religions destroy each other." Mr. Wallace next considers the modern argument, that if any number of men assert that they saw the stone lion on the top of Northumberland House come down to drink at the fountains in Trafalgar Square we should not believe them. Such arguments turn upon the assumed, but unprovable, proposition that "a large number of independent, honest, sane, and sensible witnesses can separately and repeatedly testify to a plain matter of fact which never happened at all."

The arguments of Mr. Lecky and Mr. Tylor are dealt with no less ably.

The second treatise is on the "Scientific Aspect of Spiritualism." One of its most important chapters consists of notes

of the author's own observations—his personal evidence. Some of the phenomena described are exceedingly remarkable, and the explanations proposed by physiologists utterly fail. We commend this portion especially to the attention of our readers. It is interesting to trace the opinions of a confirmed sceptic reluctantly, as it were, admitting first the facts, and then their explanation. On the other hand, it is difficult to conceive of such a man, in such a frame of mind, being imposed upon, either by his own feelings—which were working in the opposite direction—or by jugglery. We regret that we are unable to devote more space to this interesting volume.

Introductory Text-Book of Physical Geography. By the late David Page, LL.D., F.G.S. Tenth Edition, revised and enlarged by Charles Lapworth, F.G.S., &c. Edinburgh and London: W. Blackwood and Sons.

We were of opinion that the term "physical geography" had been authoritatively condemned by "South Kensington," and its use interdicted for the future under appropriate penalties. We find, however, Dr. Page and his successor and editor still declining to lay it aside in favour of the fire-new word "physiography." As we have often had occasion to remark, when a work has passed through many editions the critic finds much of his task done to his hand. The author's definition of physical geography, as distinct from descriptive or general geography, is very satisfactory. These two phases of earth-lore have, however, much in common. Both require, as their starting-point, the notion of "quarters of the globe," which in political geography works—in England at least—so much mischief. It is not too much to say that the unity of the British empire would have been much more assured, and the resources of the colonies better developed, if the latter were described immediately after the home kingdoms, instead of being slightly glanced at in different parts of the text-books.

To return from this digression, we find, as the principal features of the edition before us, a summary of the main results of the *Challenger* Expedition, an account of British storms, a description of the biological regions of the earth, and a short sketch of Prof. Huxley's arrangement of the human races. Of this added matter the last-mentioned, or ethnological portion, is perhaps the least satisfactory. Thus the "Caucasian" race of Blumenbach is an ill-assorted group as confounding together the two very distinct and antipathetic groups of nations, the Aryan or Indo-germanic and the Semitic or Aramean. We must demur

to the statement that "the Caucasian is taller than any of the other varieties." The aborigines of the most southern part of America, the Maories and the Caffers,—all, be it remarked, dwellers in the Southern Hemisphere,—are at least equal, if not superior, in stature, to any nations of the white race. We must also question the assertion that "Wherever the white man has established himself the other races disappear before him." In North America the red men, and in Australia the "black fellows," have thus faded away on coming in contact with European settlers. But recent statistics make known the alarming fact that the negro and negroid population is increasing more rapidly in America than the white inhabitants of European descent.

It is further at least questionable to include the Hottentots under the Ethiopian race, and to class together the aborigines of Australia with the Maories and the Polynesians. Mr. A. R. Wallace has pointed out the broad distinction between the Malay and the Papuan. The classification of Dr. Huxley, of which an abstract is given, avoids some of these difficulties.

The work generally is to be commended as giving not a mere description or catalogue of facts, but as tracing out their connections and causes. It appeals not so much to the memory of the student as to his reason.

A Treatise on Chemistry. By H. E. Roscoe, F.R.S., and C. Schorlemmer, F.R.S., Professors of Chemistry in the Victoria University, Owens College, Manchester. Vol. III.—The Chemistry of the Hydrocarbons and their Derivatives, or Organic Chemistry. Part I. London: Macmillan and Co.

The great work of Profs. Roscoe and Schorlemmer has, in its earlier volumes, deservedly won the favourable opinion of the scientific public. It possesses certain distinctive features which secure for it a wide appreciation even as compared with such formidable rivals as the great "Dictionary" of Watts and the well-known "Elements" of Miller. Without launching out into the boundless region of chemical technology, the work before us seems to bridge the gulf which separates theory from practical application in a peculiarly happy manner. Its illustrations, not merely of laboratory apparatus, but of industrial plant, are remarkable for their excellence and accuracy. To see how well this character is maintained in the present volume we need merely refer to the account of practical distillation and to the chapter on alcohol.

The volume begins with an ably-written historical introduction,

in which the early history of organic chemistry is sketched, with especial reference to the gradual changes in theory. Here we notice a curious clerical or typographical error: we read "The early ideas of Van Helmholt and afterwards of Stahl." The authors evidently mean to say "Van Helmont." After discussing the definitions of organic chemistry proposed in the earlier part of the century, and remarking that "at the present day the belief in a special vital force has ceased to encumber scientific progress," the authors define this portion of their subject as "the chemistry of the hydrocarbons and their derivatives,"—a more precise notion than, as was once proposed, the "chemistry of the carbon compounds."

We next come to an elaborate and thoroughly illustrated chapter on ultimate organic analysis, to which is appended an account of the various methods of determining vapour-densities, as adopted by Dumas, Gay-Lussac, Hofmann, and Victor Meyer. In the section on empirical and rational formulæ we meet with the profoundly philosophical remark, ascribed to Kekulé, that "the true aim of chemistry is not so much the study of the existing substance as that of its past history and its future development." This point of view in one sense approximates chemistry to biology, as studied in the light of the doctrine of Evolution.

After discussing isomerism, metamerism, and polymerism, the authors proceed to classify the carbon compounds under four great heads:—the fatty group; a nameless group of unsaturated compounds, containing relatively less hydrogen than the above; the aromatic group; and a mob of compounds of unknown constitution which the progress of research is daily reducing in number. Into the description of the bodies belonging to these classes there is the less need for us to enter, as wherever we have turned we recognise the accuracy which the eminence of the authors warrants us in expecting.

Concerning formic acid we may remark that the occurrence in the animal world is far more common than chemists seem to have recognised. It not impossibly stands in a close relation with the poisonous secretions of scorpions, centipedes, spiders, &c. Its great value as an antiseptic (referred to on p. 274) is a point which has been overlooked by sanitary reformers. As being at once more powerful than phenol, and free from the unpleasant odour of the latter, its industrial preparation on the large scale ought to attract the notice of chemical manufacturers.

The occurrence of common or ethylic alcohol in Nature—some cases of which are here mentioned—will be for many readers an interesting, and for others an unwelcome, fact. Concerning the so-called "methylated spirit" the authors justly remark that it is "unfit for human consumption." Nevertheless, except a very strict watch is kept in establishments where this spirit is in use,

it is consumed, and that to an unpleasant extent. It is also unfortunate that, in spite of this addition, the mixed spirit cannot be bought without a further addition of shellac, unless the consumer can comply with certain onerous conditions. It need scarcely be said that, save for the varnish-maker, shellac is one of the most unfortunate "denaturising" additions that could have been selected.

Judging from the present part, we should expect that two more volumes will be required to complete the work on its present scale.

A Treatise on Comparative Embryology. By FRANCIS M. BALFOUR, LL.D., F.R.S. In Two Volumes. Vol. II. London: Macmillan and Co.

WE have here the second and concluding part of Dr. Balfour's great work, and can now form some adequate idea of the labour and research which have been required in its compilation. In the first ten chapters of the volume the author expounds the developmental history of the Chordata from the Cephalocorda up to the Mammalia. In the eleventh chapter we find a short comparative review of the formation of the germinal layers and of the early stages in the development of the Vertebrata, the author treating successively of the formation of the gastrula and the behaviour of the blastopore, with the origin of the hypoblast; the mesoblast and notochord; and lastly, the epiblast. From the last-mentioned are formed the central nervous system, and the epidermis, which also takes a main share in the formation of the organs of special sensation.

From the hypoblast are formed the epithelium of the digestive canal, of the trachea, bronchial tubes, and air-cells, the cylindrical epithelium of the ducts of the liver, pancreas, &c., and the spheroidal secreting cells of the pancreas and other glands. From the monoblast are formed the true skin, the muscles, the skeleton, the vessels, generative and urinary organs. It is particularly noted that the epithelium of the urinary glands, though resembling the hypoblastic epithelium of the alimentary canal, is nevertheless mesoblastic.

The interesting question of the growth of the vertebrate embryo is next discussed. On this subject two views prevail. The author, in common with the generality of embryologists, holds that, *e.g.*, the Elasmobranch embryo arises from a differentiation of the edge of the blastoderm, extending for some little distance inward from the edge. This differentiation is considered to comprehend the rudiments of the entire embryo, except the yolk-

sac; and its hinder end, at the edge of the blastoderm, appears to correspond with the same extremity of the mature body. Growth in length depends on a process of intersusception, and, until the full number of mesoblastic somites are formed, it is effected, as in the Chætopods, by the constant addition of somites between the one last formed and the posterior end of the body.

On the other hand, His and Rauber assert that growth in length is effected by a coalescence of the two halves of the thickened edges of the blastoderm in the median dorsal line. The arguments in support of this view are, briefly stated, the general appearance, certain measurements which to the author seem mainly to prove that the growth takes place by the addition of fresh somites between the end of the body and the last-formed somite, and, lastly, certain phenomena observed in double monsters. An examination of the growth of the embryo proves, however, that points brought forward by His and Rauber are far from conclusive, and that the growth in length of the greater part of the body certainly takes place, as in the Chætopods, by the growth of fresh somites. Hence it would be strange if a small part in the middle of the body should grow in a different way. If the vertebrate blastopore had the same extent as the dorsal surface, as His and Rauber assert, this should appear in *Amphioxus*. But in this species it is at first placed quite at the hind end of the body, and nearly closes up before the appearance of the medullary groove or the mesoblastic somites. The medullary folds have nothing to do with its lips. Again, in the Vertebrates the food-yolk is situate on the ventral side of the body, and is enfolded in the blastoderm. Hence in all "large-yolked" forms the ventral walls are completed by the lips of the blastopore closing on the ventral side.

On the "concrescence" hypothesis of His and Rauber the dorsal walls are also completed by the closing of the blastopore, so that the concrescence of its lips would form both the dorsal and the ventral, as well as the dorsal walls of the embryo. This consideration Dr. Balfour thinks amounts to a *reductio ad absurdum* of the whole theory.

In Chapter XII. the author discusses the ancestral form of the Chordata. He considers it clear that the ancestors of the Chordata were segmented, their mesoblast being divided into myotomes, which even extended into the region in front of the mouth; so that the head, as well as the trunk, was segmented. The only internal skeleton was the non-segmented notochord. Hence Dr. Balfour draws the corollary that the skeleton is of relatively little value for the decision of many fundamental questions. The region which now forms the œsophagus and stomach was in the ancestral forms severed by gill-clefts. The mouth had a suctorial character, and had its place on the ventral surface behind the pre-oral lobe In the higher types it has gradually become modified to a biting structure, and has been

removed to the front of the head. The alimentary canal probably extended to the end of the tail, and the present anus in the Vertebrates is therefore not the original one, but is a formation not inherited from any older group, but acquired within the group of Chordata. This transference of the anus is not easily accounted for on the Darwinian theory.

At the end of this chapter we have a tabular scheme of the phylogeny of the Chordata. We find a series of hypothetical groups—the Protochordata, from which are supposed to spring the degenerate existing groups of Urochorda and Cephalocorda, and the hypothetical Proto-vertebrata. From these are descended a degenerate type, the Cyclostomata, and another hypothetical group, the Proto-gnathostomata. These give rise to the actual Elasmobranchii and Holocephali, and the hypothetical Proto-ganoids, from which spring the existing Dipnoi, Ganoids, and Teleostei, and the hypothetical type Proto-pentadactyloids. These are the ancestors of the real amphibians, and of a final hypothetical group, the Proto-amniota, the progenitors of the Sauropsida (birds and reptiles), and of the mammals. It is considered probable that the mesozoic Plesiosauri and Ichthyosauri were more closely connected with the Proto-pentadactyloids than either to the Amphibia or the Prota-amniota.

The thirteenth chapter is devoted to an examination of the origin and homologies of the germinal layers, and to the consideration of the nature, origin, and affinities of larval forms. Here, from the difficulty of the subject, and often from the absence of the necessary researches, the author aims more at summarising and criticising the views of others than at coming to any final decision. He considers that the gastrula reproduces, more or less closely, a stage in the development of the Metazoa which is permanent in the simpler Hydrozoa when the organism possesses a fully developed digestive cavity lined by the hypoblast and endowed with assimilative powers. An oral aperture and an epiblast were in existence. The following weighty questions, however, remain, as the author admits, unsolved:—"By what steps did the compound Protozoon become differentiated into a Metazoon? Are there any grounds for thinking that there is more than one line along which the Metazoa have become independently evolved from the Protozoa? And to what extent is there throughout the Metazoa a perfect homology between the two main germinal layers?"

The section on larval forms begins with a comparison of larval and fœtal development. Whilst examining this chapter we could not help regretting that so few embryologists are entomologists, or so few entomologists are embryologists.

The remaining eleven chapters of the work, which want of space does not allow us to summarise, are devoted to organogeny. The author treats in succession of the epidermis and its derivatives; of the nervous system; the organs of vision, hearing,

scent; the indefinite sense organs of the median line; of the notochord, vertebral column, ribs, and sternum; the skull, pectoral and pelvic girdles and limbs; the body cavity and vascular system; the muscular system; the excretory and generative organs and the alimentary canal in the Chordata, with its appendages. It seems to us that in this survey the insects fare worse than any other great department of the animal kingdom, not from any intention on the part of the author, but from the frequent want of the necessary materials.

The work is abundantly and well illustrated, and every division is furnished with an elaborate bibliography. As to the value and utility of the book, we must admit it to be on its subject without a worthy parallel in the language. It is equally suitable as a manual for the student, and as a work of reference for biologists of old standing.

Inorganic Chemistry, Theoretical and Practical. An Elementary Text-Book designed primarily for Students of Science-Classes connected with the Science and Art Department of the Committee of Council on Education. By W. Jago, F.C.S., A.I.C. London: Longmans and Co.

We should much like to see an accurate return of the number of elementary text-books on chemistry which have appeared within the last dozen years, all of them, or nearly so, compiled with a special reference to the examinations of the Science and Art Department. How it comes that there is scope for so many works covering the same ground, and how publishers are prevailed upon to bring them out, are unsolved problems. It would be a very different case if there were in England, as in Germany, and to some extent even in France, a number of eminent and independent schools of chemistry, each possessing some distinctive feature. But with us South Kensington reigns supreme, and lays before every student a *quicunque vult* from which there is no dispensation. In consequence all our text-books and manuals bear the same stamp.

To do him justice, Mr. Jago feels the difficulty of the situation. He begins his Preface with certain remarks so sound and judicious that we cannot help quoting them at some length:—"The teacher of classes which are in connection with the Science and Art Department has to face special difficulties. In addition to his desire to give his students a thorough knowledge of their subject, he must necessarily remember that it is all-important to him that good results be obtained at the Department's examinations. Unless, therefore, he is prepared to sacrifice the true

teaching of the subject altogether, he must perforce keep in view two ends that are distinct from each other. The writer of a special text-book such as this encounters the same difficulty; there is, on the one hand, the strong temptation to treat the subject so as to give a sound elementary basis of knowledge, regardless of examiners and examinations; or, on the other, to study the idiosyncracies of particular examiners, and simply to provide the material for answers to their questions."

We have seldom seen the case against the Science and Art Department put so tersely, so calmly, and yet with such overwhelming power. Here is the admission that a "thorough knowledge"—say, of chemistry—does not necessarily imply success at the examinations; that the latter object is something perfectly distinct from the former; and that teacher and pupil are both encumbered by attemping to combine two incongruous aims. It is further confessed that "to sacrifice the true teaching of the subject" is a way, and an easier way, to good results at the examinations. It is further plain that examination no longer seeks to play the humble though perhaps necessary part of a test of the student's knowledge; it is made not a means, but an end. Hence all teachers who do not indulge in the costly luxury of a conscience do actually sacrifice true teaching to getting a large proportion of their students to pass. Hence those pseudo-students who have no love for Science, and who seek merely certificates, medals, and degrees, are enabled to thrust sterling merit into the background.

The "Science and Art Department" is one of the saddest mistakes into which a nation ever fell; and if we wish to make sound progress in Science, pure or applied, one of our first steps should be its total abolition.

Technical Vocabulary, English-French, for Scientific, Technical, and Industrial Students. By Dr. F. J. Wershoven, Author of the English and German and French and German Technical Vocabularies. London and Paris: Librairie Hachette et Cie. Boston: Karl Schœnhof.

This useful little work is divided into three sections. The first gives, in parallel columns, the French and English technical terms used in mechanics and in all the branches of physics; the second section treats, in the same style, of chemistry and metallurgy; whilst the third is devoted to machinery, railways, and to certain arts and manufactures. Astronomy and biology, with the applications of the former in navigation, and of the latter in medicine, agriculture, &c., are not included.

The general character of the work is thorough accuracy, the more to be noted as neither French nor English is the author's native language. Yet with scarcely an exception his English is that of an Englishman, and his French, as far as we can judge, that of a Frenchman, well acquainted with his subject. The value of the work for Englishmen who wish to make themselves acquainted with the technical literature of France is indisputable.

Elementary Treatise on Physics, Experimental and Applied. For the Use of Colleges and Schools. Translated and Edited from Ganot's "Eléments de Physique," by E. Atkinson, Ph.D., F.C.S. Tenth edition, revised and enlarged. London: Longmans and Co.

The editor and translator of this work is guilty of no departure from the truth when he refers to the "continued and increasing favour" which it experiences both as a college manual and as a work of reference. The subject-matter has been brought to a level with the present state of knowledge. Thus the researches of Cailletet and Pictet on the condensation of oxygen, &c., are now duly noticed, and the category of permanent gases has consequently disappeared. The recently invented electric-acoustic instruments, such as the photophone, are duly described and figured. The electric light and the various systems for its production are spoken of at some length, and the interesting experiments of Siemens on its effects upon vegetation are described. Paragraphs are devoted to the experiments of De la Rue and Miller on the stratification of the electric light, and to the phenomena observed by Crookes on producing the electric discharge in tubes very highly exhausted. The theoretical views which Mr. Crookes has deduced from his results are referred to merely as being still *sub judice.*

The subject of polarised light, which if our memory serves us was to some extent overlooked in former editions, now receives due attention.

In estimating the value of this work we must take into account the translator's reservation that it does not and cannot attempt to give an exhaustive account of any one branch of Physics, since such an undertaking would be inconsistent with the purpose of a college text-book, and in so voluminous and rapidly-growing a science would be impracticable even within a fourfold larger compass. What the author and translator have aimed at is ably, accurately, and clearly done, and we can have no hesitation in giving the work as it now stands our cordial recommendation. There is a very complete index, the references being not to the pages, but to paragraphs.

Evenings at Home in Spiritual Séance. Prefaced and Welded together by a Species of Autobiography. By Miss Houghton. First Series. London: Trübner and Co.

Never in our experience have we met with a more perplexing book than the one before us. It would of course be exceedingly easy for some critics to turn the author and her narrative into ridicule, and to dismiss her as an impostor or a lunatic. Unfortunately for ourselves we cannot dismiss difficult problems so lightly. Whoever reads these "Evenings at Home" in a candid spirit must at least admit that Miss Houghton writes in perfect faith, fully believing every statement which she has advanced. But are the sights, the sounds, which she has experienced and recorded, objective realities or merely illusions? Here is the difficulty. Miss Houghton may be of an enthusiastic, imaginative temperament, and may possibly have mistaken subjective imagery for external objects. We do not say this dogmatically, but doubtingly, and well aware of the exceeding imperfection of human knowledge concerning all those phenomena which are classed as mental. Let us call attention to certain points: the lady in question is, if not an artist by profession, evidently an admirer of art, acquainted with living artists, and not unfamiliar with the names and the peculiarities of the great masters of the past. Accordingly she becomes a drawing medium; she is brought into communication with the spirits of Sir Joshua Reynolds, Salvator Rosa, Claude Lorraine, Parmegiano, Vandyck, &c. Again: she is evidently a devout Christian, well read in religious literature in general, and especially in the Bible. We find her brought in communication with the archangels Gabriel and Michael, with the spirits of Abraham, Moses, Aaron, Luther, Elias, &c. We cannot help asking whether the same forms would have appeared to Miss Houghton had she been brought up among different surroundings and different traditions? We know, of course, that to this objection a reply may be made. It may be said that artist-spirits were by a natural affinity attracted to the living artists, and saints and angels to the devout believer.

Perhaps the most satisfactory proceeding will be to quote the author's account of the evidence which originally made her a Spiritualist, so that our readers may judge for themselves concerning its validity. In the year 1859 she was told by her cousin, Mrs. Pearson, that there were means by which it was possible to communicate with the spirits of lost friends. The two ladies made, accordingly, a visit to Mrs. Marshall, who with her niece "sat with us at a round table. In a short time the raps came." . . . "My youngest sister, Zilla," who died in 1851," was again in conversation with me, and I asked whether anything still troubled her, to which she answered 'Yes,' and on my enquiring what it was, naturally concluding that it would refer to her

husband or children, I was surprised by the word 'Helen' being spelt out. Helen was another sister, three years older than herself, who had married a Catholic, and had been led away to the same church. This had troubled Zilla on earth, and I felt it was still a grief to her." Miss Houghton comments on this occurrence as follows:—"The name of Helen could never have been the coinage of Mrs. Marshall or her niece, nor was she at all in my thoughts, but I immediately understood what Zilla meant." The question then naturally arises, How is this to be accounted for? Supposing, for argument's sake, that Mrs. Marshall and her niece were jugglers, what should lead them to conclude that Zilla would be thinking of a sister rather than of her husband and children? It is not indeed expressly stated, but we should judge from the passage that Mrs. Marshall had no previous acquaintance with Miss Houghton and her family. We read further "Later in the evening the planchette was brought forward, and on it were placed Mary Brodie's hand (the niece of Mrs. Marshall) and my cousin's (Mrs. Pearson). I then asked her how many years it was since the first brother I had lost had passed into spirit-life? A 3 was written, and my cousin (who was thinking of another brother) said, 'It is going to be 13.' Instead of which another 3 was added, which was correct, for it was thirty-three years since I lost my dear brother Cecil Angelo."

These two tests were for Miss Houghton sufficient. But it is right to add that very singular, even startling, occurrences are narrated in the course of the book which are exceedingly difficult to explain on any other supposition than either wilful deceit or the intervention of intelligent beings other than men and women as we meet with them in life. Some of the cases are of such a nature that accidental coincidence is scarcely thinkable. We quote as a subject for reflection the following remark:—"I think most of my readers will be able to remember some occasion when a thought will seem to have flashed into their minds without any connection with their then train of ideas, and they may feel assured that it has been thus deposited in their brain by some external agent, and probably for a specific purpose."

The author learnt from a Mr. Hyde that the celebrated Sir H. Bessemer in the early part of his career saw, in a dream, the way to overcome a practical difficulty in connection with a type-distributing-machine which he was then engaged with. She ascribes this to the intervention of spirits—an explanation which we do not think necessary. We have learnt, however, that a gentleman, who has made some signal improvements in connection with the alkali manufacture, considers that he has been assisted by spiritual agency.

The following is a curious statement: "One Sunday in 1862, soon after the clergyman had gone into the pulpit, I saw him irradiated with a violet light like a globe of about 2 feet in diameter, the central point of which appeared to be placed at the

heart. A Sunday or two later another clergyman preached, when again a violet sphere was shown me, but this was larger, at least 3 feet in diameter. On the next occasion a stranger occupied the pulpit, and he was in like manner surrounded by a delicate green light."

In connection with this we venture to put the following: "She (Mrs. Hallett) afterwards saw a beautiful spirit-light, which seemed to descend from the north-west and gradually spread out as if on all sides. It was to me very striking that light should come from the north-west, for in all my drawings that has been the point of glory." Have we here some luminous phenomenon accompanying or connected with terrestrial magnetism, and under conditions yet unknown visible to man? Are all organic beings enveloped in globes of coloured light?

The author, as well as a Mr. Spear often here mentioned, speaks of numbers as good or bad. Every multiplicand or dividend of twelve is good!

Miss Houghton is convinced of "the spiritual sight of animals, and their after life." But the instance which she gives in support of the former view, and which we cannot quote from want of space, is by no means conclusive.

A strange story, given on pp. 63 and 64, is that of Mumler, the Boston photographer, who, taking a photograph of himself one day when perfectly alone, found on developing the picture, the image of a second person beside his own, and recognised it as that of a cousin, who had been dead about twelve years! All here turns on an unknown quantity—the truthfulness of Mumler.

Those of our readers who are able honestly and fairly to suspend judgment in doubtful cases, and who are not beset with "Dominant Ideas," will find this book worth carefully reading.

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

DARKNESS IN MASSACHUSETTS.

To the Editor of the Journal of Science.

SIR,—About a fortnight since the telegrams from America stated that almost complete darkness was experienced during the day in Massachusetts. I have not seen any further account of it in the London papers. Have you seen any explanation of this phenomenon?

I find, in the "History of Lynn, Massachusetts," under the "Chronological Table," the following:—

1716. Extraordinary darkness at noonday, October 21st: dinner tables lighted.

1780. Memorable dark day, May 19th: houses lighted as at night.

—I am, &c.,

CHARLES W. HARDING.

INSECTS DURING THE PAST SEASON.

To the Editor of The Journal of Science.

SIR,—Perhaps the following notes in illustration of the influence of seasonal peculiarities upon animal life may be of interest to some of your readers. It will be remembered that the spring and early summer of 1881 were uncommonly dry, cold, and bleak; that we had a short fit of unusual heat in July; and that since the end of the first week in August the temperature has been low, rain abundant, and high winds plentiful.

A prominent feature has been the general rarity of wasps: bee-keepers, and growers of grapes, peaches, &c., under glass, report very unanimously that they have had no trouble with these marauders throughout the season. A few have appeared in sheltered places at the end of September and the beginning of October. Hornets have been still scarcer. In the neighbourhood of Chingford, Sewardstone, &c., where they are usually common, none have been seen.

The cockchaffer and his diminutive successor, *Rhisotrogus solstitialis*, have both been scarce, and have occasioned no damage.

The currant-moth (*Abraxas grossulariata*) has not been plentiful. Gooseberry and currant bushes, which were much infested with its larvæ in 1879 and 1880, have been this year nearly free. The yellow underwing (*Tryphæna pronuba*) was very plentiful, but only for a short time. *Orgyia antiqua* has been very plentiful in the suburbs of London and the country districts around, and has done much mischief.

Earwigs have been abundant almost beyond precedent during the whole season. Lettuces in May, roses and carnations in the summer months, and dahlias and asters in September and October, have been full of these pests.

The crane-flies have been scarce, but gnats and biting flies (*Stomoxys*) very abundant. Dragonflies have been unusually scarce.

In connection with the multitudes of gnats, I may mention the scarcity of swallows. I know an instance of a mansion where a few years ago they were very abundant, and where they were carefully protected by the proprietor. This year there have been scarcely any.—I am, &c.,

S.

NOTES.

In a paper read before the Entomological Society, by Mr. R. McLachlan, F.R.S., a decided case of parthenogenesis among Coleoptera was recorded. A virgin female *Gastrophysa raphani* deposited several successive batches of eggs at intervals of several days, and in each batch one egg at least proved fruitful.

Dr. Rush, of Philadelphia, gives ("Science") an interesting case of regressive recollection of languages. Dr. Scandella, a learned Italian, residing in America, had a complete mastery of French and English, as well as of his native tongue. Being attacked with yellow fever, in the beginning of his illness he spoke English only. As he became worse he spoke nothing but French, and on the day of his death Italian only.

The "Social Science Congress" is, even more than the British Association, in danger of becoming a political debating society. It is doing everything but constituting sociology.

According to Mr. A. Strahan ("Geological Magazine") the coal found beneath the New Red Sandstone, in the south-west of Lancashire, is for the present not likely to be of practical importance.

Prof. Barrett ("Psychological Review") questions Dr. Carpenter's—or we should rather say Dr. Beard's—explanation of "thought-reading."

The "Scottish Naturalist" gives an obituary notice of the late Robert Walker, F.G.S., Registrar of the University of St. Andrews, a zealous and successful observer in geology and marine geology.

Prof. Seeley, F.R.S. ("Geological Magazine"), after a careful comparative examination, maintains that the London and the Berlin specimens of *Archæopteryx* belong respectively to different species.

The Rev. F. O. Morris writes to the "Morning Post" that a specimen of the Californian quail has been recently shot near Huggatt, a village on the Yorkshire Wolds.

According to M. Ravaisson ("Comptes Rendus") the unpublished manuscripts of Leonardo da Vinci contain suggestions for aërial locomotion, a description and diagrams of a steam-cannon, and an account of a device for hearing distant sounds, either on land or sea. (It must be noted that, like certain inventors of the present day, Da Vinci turned his attention chiefly to appliances for warlike purposes.)

Prof. Peirce, in a publication bearing the very curious title "Sketches and Reminiscences of the Radical Club," maintains that if meteors did not fall into the sun the temperature of the earth would sink to -200° or -300°.

Dr. F. Buchanan White, F.L.S., gives, in the "Scottish Naturalist," an interesting account of the habits of *Dytiscus lapponicus*, a large carnivorous water-beetle, occurring in Britain only in the Isle of Mull, in Strathglass, and in Donegal.

Mr. E. Wethered, F.G.S., in a memoir on the "Formation of Coal" read before the British Association, contended that coal was not formed from trees of the Lepidendroid type; that the *stigmaria* found in the under clays are not the roots of the vegetation which gave rise to the coal; and that the varieties of coal are not due to metamorphism, but depend on the different degree of decomposition of the vegetable mass when submerged. He argues that coal must have been formed from a compact mass of vegetation, and could not have arisen from large trees growing *in situ*.

Mr. T. R Jones ("Geological Magazine") states that the horns of *Cervus Megaceros* obtained in Berkshire were found in the peat itself, and not in the underlying clays.

Dr. E. C. Spitzka ("Science") found in the egg of a turtle (*Chrysemys picta*), laid in his experimental tank, "a live maggot, the larva probably of *Musca vomitoria*, crawling in the space between the half-dried yolk and the shell membrane." He observes that foreign bodies have frequently been found in hen's eggs, as legs of beetles, straw, &c.; but he believes there is no case on record of a living animal occurring in an egg. (We once found in a hen's egg a small piece of printed paper.)

The "Medical Press and Circular" is ably pointing out the permanent and serious injuries which often result from bodily punishments as administered in schools.

Dr. Sharp has discovered, in the Sandwich Islands, thirty-four species of insects new to Science.

Mr. "Stuart Cumberland" has been enlightening the Church Congress on the subject of Spiritualism.

Two curious facts appear in the writings of the so-called Theosophists: the re-habilitation of the ancient elements, fire, air, earth, and water; and the inculcation of asceticism as the road to superior wisdom and power.

The election of a Lord Rector is about to take place at the University of Aberdeen, and we much regret that the contest will probably be fought on political grounds.

Two species of *Phasma* are occasioning great damage among the cocoa-nut plantations of the Fiji Islands.

The resolution in favour of vivisection unanimously adopted at the late International Medical Congress leaves something to be desired. It asserts merely "That this Congress records its conviction that experiments on living animals have proved of the utmost service to medicine in the past, and are indispensable for its future progress; that, accordingly, while strongly deprecating the infliction of unnecessary pain, it is of opinion that, in the interest of men and animals, it is not desirable to restrict competent persons in the performance of such experiments." It seems to us that the resolution covers only experiments made with a distinctly medical purpose. The word "competent" is, further, invidious. We regret the want of union between the medical profession and non-medical biologists on this important subject.

Mr. Harley Barnes ("American Naturalist"), whilst denying that animals possess reason, neatly refutes himself by admitting that they "reason from cause to effect."

Prof. W. J. Beal, addressing students of botany, most wisely says "Beginners should study plants and refer to books, and not study books and refer to plants."

An Italian, upon whom adjectives would be wasted, has lately been boasting of the numbers of swallows which he has shot. We should like to have him stripped naked, and tied to a tree in a certain district in the Lower Danube Valley. Before the next morning the mosquitoes and sandflies would have convinced him of the value of bird-life.

The blackbird is now recognised as having an occasionally carnivorous and predatory character.

Prof. Von Pettenkofer, at the recent meeting of the German Congress of Naturalists and Physicians, maintained that the sanitary condition of the soil was of the highest moment, whilst the air and the waters, if polluted, soon purified themselves again.

The larva of *Crambus vulgivagellus*, a small moth belonging to the Pyralidæ, has this year destroyed the grass over many hundreds of acres in the State of New York.

The Hon. W. Bross, in a paper read before the American Association for the Advancement of Science, ascribes the origin of canons not to the erosive action of rivers, but to "some great convulsion of the earth's surface, or the contraction of mountain chains from their igneous condition in the early history of the planet."

Prof. Owen ("Journal of British Dental Association") maintains that the alleged cases of a third set of teeth are merely the reappearance of old and worn stumps, in consequence of the shrinkage and absorption of the jaw.

With reference to the hay- and corn-drying machine described in our October issue, we may mention that a contemporary estimates the loss sustained in the United Kingdom, from the bad harvests of 1879 and of the current year, at £150,000,000.

French papers report that a dog at Metz has—not from its own folly, but by being shut up—gone through a fast of thirty-nine days in duration. He has recovered.

The names of the Committee for the forthcoming Electrical Exhibition at the Crystal Palace are duly announced. Sir H. Cole is of course included, but why, oh why, is Mr. Buckmaster left out in the cold?

The fifty-fourth meeting of the Congress of German Naturalists and Physicians took place this year at Salzburg, from the 18th to the 24th of September, and was complicated with an Exhibition.

A Sanitary Congress was held at Vienna on the 14th of September and following days. M. Knauff, of Berlin, argued strongly in favour of a double system of sewerage, the rain-water, &c., not being allowed to mix with and dilute the sewage properly so called.

According to Dr. Mylius ("Pharm. Central Halle") only 0·001 grm. oxide of copper was extracted from the intestines of a girl poisoned with "Schweinfurt green," although 130 grms. of the liver, 60 grms. of the kidneys, and half the stomach and its contents were operated upon.

Lycopodium complanatum, L., is stated by Bödeker to contain more alumina than any other plant.

We regret having to notice the death of Prof. Schützenberger, of Strasbourg.

Sir Joseph Hooker considers that the flora of the Southern temperate zone has been derived from the Northern temperate regions.

According to Oscar Löw ("Berichte Deutsch. Chem. Gesell.") he has demonstrated the existence of free fluorine in the fluor-spar of Wölsendorf.

W. B. Schmidt ("Mineralog. Mittheilungen") points out that sulphurous acid is rare among the products of Vesuvius, and of the volcanoes of equatorial America; more common in Etna; and abundant in the Lipari, the volcanoes of Iceland, and especially in those of Java.

M. Ziegler, of Geneva, announces two magnetised iron bars, joined together in a certain manner, produce definite effects upon animals, which differ according to the angle of intersection of the bars. Prof. C. Vogt pronounces the discovery of importance.

The "London Quarterly Review" for October contains an exceedingly able but severe critique on the writings of Dr. Maudsley. The reviewer, however, ignores those proofs of moral life in animals which the unbiassed naturalist meets with frequently.

According to the "Bibliotheque Universelle," in France the term "Darwinism" is considered practically synonymous with "atheist." Certain ecclesiastical writers assert, and even seem to believe, that Mr. Darwin's primary object was anti-Christian and anti-theistic !

M. Laségue ("Revue des Deux Mondes") gives a very eulogistic summary of the researcees of Mr. Braid in "Animal Magnetism."

At the recent Congress of German Naturalists and Physicians Geheimrath Weisman read a paper on the duration of life and the cause of death. He considers that the very various durations of life in different species is not determined alone by morphological and physiological laws, but depends on an adaptation of each species to vital conditions. The cause of death he seeks in a limitation of the reproductive power of the cells. Death is a phenomenon of adaptation, immortality having been lost by the higher animals when no longer needed. An Amœba may be destroyed, but it has no fixed term of life, and its death is not a matter of necessity.

M. E. Yung ("Comptes Rendus") has made a series of experiments on the action of poisons upon the Lamellibranchiate mollusks. Atropine produces no appreciable effect ; strychnine is fatal only when placed in direct contact with the heart.

A pair of twins, Jacob and Baptiste Jocci, are now being exhibited at Vienna. They are grown together from the sixth rib downwards, and have but one abdomen and two legs. Each child thinks, speaks, sleeps, eats and drinks independently of the other. One may even be indisposed without affecting the other. —*Medical and Surgical Reporter.*

M. Robin has exhibited before the Société de Biologie a specimen of blue urine, passed by a patient suffering from interstitial nephritis. The colour is supposed due to the decomposition of indican.

Dr. G. M. Sternberg ("National Board of Health Bulletin"), from observations made on the mud in the gutters of New Orleans, concludes that pathogenic bacteria are bred not alone in the bodies of animals.

At the last meeting of the Royal Microscopical Society Mr. J. W. Stephenson exhibited a slide of diatoms mounted in a saturated solution of phosphorus in bisulphide carbon. The refractive index of this medium is about 2·10, while that of diatomaceous silex is 1·43, the visibility being greater than the same

object mounted in balsam in the ratio of 11 to 67, and greatly exceeding the visibility of the same objects mounted in air. In this latter medium they could not be examined with any advantage under the recently constructed objectives, having a numerical aperture exceeding 1·0. Tqe practical difficulties of mounting in a solution of phosphorus are very great, owing to the inflammability of the medium, so that, good as the results are, it will probably be but seldom employed.

The new "Periscopic" eye-piece of Mr. Gundlach consists of a triple eye-lens and a double-convex field-lens, the latter being situated *within* the focal distance of the former, and a diaphragm placed in the focus of the equivalent of the two lenses. The field of the new eye-piece is larger than that of Kellner, and the image is sharply defined to the extreme edge. As the focus of the eye-piece lies behind the field-lens it is particularly suitable for micrometers, especially as the divisions are distinctly visible to the extreme edge, which is not the case with Ramsden's eye-piece.

NOTE.—Absence from London having prevented Mr. Reichenbach from seeing proof-sheets of his article in Nos. 93 and 94, he apologises for the errata therein.

NINETEENTH YEAR OF PUBLICATION.

THE

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THE

JOURNAL OF SCIENCE.

DECEMBER, 1881.

I. SOME RESULTS OF GRAVITATION.

By Charles Morris.

IN considering the general results of the Newtonian law of gravitation we arrive at an interesting deduction, which it may be well to briefly describe. This is that, if we view the matter of the universe surrounding any central particle as made up of successive spherical shells, constantly increasing in diameter outwardly, then this particle must exert a precisely equal attraction upon each of these shells, no matter what its diameter, provided they be of equal density and of inappreciable thickness.

Such a result necessarily flows from the law of diminution of attractive energy with distance. The force of gravity diminishes in the ratio of the inverse square of distance. At twice the distance the gravity is reduced to one-fourth. At three times the distance to one-ninth. But at twice the distance the surface area of such a hollow shell is increased fourfold; at three times the distance ninefold. Thus, as the radii of these shells increase, their surface areas increase in the same proportion as the vigour of attraction diminishes, namely, in the ratio of the square of the radius. If we take two such shells, one with twice the radius of the other, then the attraction of the central particle upon every portion of the surface of the smaller shell will be four times as great as that upon an equal portion of the surface of the larger shell. But the whole surface area of the larger shell is four times that of the smaller. Therefore the vigour of attraction upon this whole surface must just equal that upon the whole surface of the smaller. If the radius of the larger were

three times that of the smaller, then the attraction upon a unit portion of its surface would be reduced to one-ninth. But the area of its surface would be nine times that of the smaller. Consequently the attraction upon the whole surface of each must be the same.

In fact the areas of spherical surfaces increase under the same law as that by which the force of gravity diminishes. No matter, then, what the difference in diameter, the above principle holds good, and the attractions of a central particle upon every possible spherical shell of unit density must be equal. Of course the same principle will apply to all similar and proportional portions of such surfaces, though the one contain but a single molecule, and the other myriads of molecules.

These surfaces must be infinitely thin for an exact application of the law, and the existing equality is that of possible, not of actual, attractions. It could become actual only in the case of the two shells being exactly equal and uniform in density. Gravitative attraction is not a positive, but a relative vigour. Each atom pulls upon every other atom with an energy dependent upon the distance and the reverse attractive energy of this atom. Here, as in every case, action and reaction must be equal, and the total attractive energy exerted by the atom must be just equal to the total attraction exerted upon it by all the other attracting atoms in the universe. Its total energy is, therefore, subject to extreme variations. If an atom be removed from the sun's centre to a position in space midway between the Sun and Sirius, its total attractive energy would be greatly decreased.

The principle of equal attraction on equal spherical shells of unit density will enable us better to appreciate this principle of loss and gain. The total attraction of a central particle must depend on the total number of such shells into which all other particles can be formed. The possible number of these is largely influenced by the location of the particle. For the quantity of matter necessary to compose such a unit shell increases with distance in the ratio of the square of its radius. In contiguous space a very small quantity of matter would form a unit shell. In remote space a very great quantity of matter would be requisite. Consequently the possible number of such shells depends upon the greater or less contiguity of matter as a whole. If the average distance of all matter be greater in one case than in another, then each unit shell will consume more matter, and the possible number of such shells decrease.

The total attraction of the central particle will decrease in proportion. A particle in the centre of the sun is surrounded by dense contiguous matter, one in open space by rare contiguous matter, while the more distant matter of the universe does not greatly differ in its relations of distance to the two particles. Therefore the first is subject to a much greater total attraction than the second, and its reverse energy of attraction is much greater. The attractive energy of a particle, then, is far from being a constant quantity, but varies with every variation in the relations of distance of surrounding matter.

These variations in attractive energy appear to make themselves instantaneously felt by all matter, there being no indication that time is necessary for the movement of this energy. We may not be able to comprehend the cause of this instantaneous action, but we may draw a certain deduction concerning it. For if the central particle has an equal attraction upon every possible shell of surrounding matter of equal density, it follows that it has an attraction upon every existing shell in proportion to its density, and upon every segment of such a shell in proportion to the density of this segment. Thus the attraction of a central upon an exterior particle is governed by the following rule: —Supposing that the attraction of the central particle upon the whole surface of a shell of unit density be taken as a unit of attraction,—if, then, any exterior particle be reduced to unit density and thickness,—it will form a certain fraction of the whole area of a unit shell, and will be attracted by that fraction of the unit attraction.

Let us suppose lines to be drawn from the central particle to every portion of the edge of the exterior particle thus reduced. These lines will compose a solid angle. If now the exterior particle be moved so as to form part of the surface of a shell of half the diameter of the preceding, and a solid angle again formed, this angle will be four times greater than the preceding one. Instead of saying that the attraction is increased fourfold, we may say that the angle or the leverage of attraction is so increased.

We may then affirm that the vigour of attraction depends upon the degree of leverage exercised, masses of unit thickness and density, which form the same solid angle at an attracting centre, being equally attracted, whatever their distance from that centre, or their relative sizes. If any mass approach the centre the angle increases, if it recedes from the centre the angle decreases, and the leverage of attraction increases or decreases in accordance. If a particle

fall towards another it is scarcely correct to say that the vigour of attraction constantly augments, with the idea of an instantaneous projection of increased increments of attraction from one particle to the other. It seems more correct to say that the effectiveness of a fixed and constant vigour of attraction augments as its leverage increases, or as the solid angle subtended by the falling particle increases in dimensions. The central particle seems to send out lines of attraction which extend throughout space, with equality of possible energy at every distance. The number of these lines cut by a mass of unit thickness determines its gravitation towards the particle. If it approach the particle it cuts an increased number of lines; if it recede it cuts a diminished number; and the effective attraction increases or diminishes accordingly. If, finally, the attracted mass exceed the unit thickness, it may be viewed as a series of separate unit masses, each feeling a separate vigour of attraction. If it vary from the unit density the attractive vigour also varies in accordance, there being more or fewer of the lines of possible attraction cut by the matter of the mass. This idea of lines of attraction is given but as an illustration. There is no real attraction except where matter is encountered, and such a line encountering a small quantity of matter would feel a far less vigorous attraction than one which encountered a great quantity of matter. The acting particle is, of course, forced to move in the direction in which the effective energy of its lines of attraction is greatest.

Leaving this abstract deduction from the principle of Gravitation, we may proceed to review certain concrete results of its action, in connection with the action of other physical forces. Returning again to the question of terrestrial gravity, it may be well to consider the results likely to arise during the condensation of a nebular mass into the present condition of the earth, through the action of gravity. In this process gravity has one opposing energy to overcome —that of heat. And the final result must depend on the inter-relations of attraction and of heat dissemination.

If the density of the original nebula approached uniformity, then the greatest energy of attraction towards the centre must have been felt at the surface. The process of condensation, however, would soon produce an interior compression, the region of greatest weight per unit volume extending inwardly. But this compression would be resisted by the generally distributed heat of the interior matter. And as the centre was approached condensation would be less and less assisted by gravity as a direct agent, since

gravity must decrease in vigour downwards, and become null at the centre.

The heat contents of such a nebular mass may be considered as absolute heat, the temperature being to a certain degree uniform. But the effect of gravitative condensation, either directly through attraction or indirectly through compression, necessarily rendered some of the latent heat sensible, and thus increased the temperature of the condensed regions of the nebula. The resistance to compression would be the same whether this heat existed as sensible or as latent heat; but as soon as it became sensible the disturbance of temperature equilibrium introduced a new element into the case. The heat commenced to flow from the denser to the rarer portions of the nebula, thus tending to reproduce temperature equilibrium, but to overthrow the original heat equilibrium. As compression, with its disturbance of temperature, must have first made itself felt near the surface, the heat yielded would act to hinder its extension downward. This heat must be first got rid of ere compression could effectively descend. But the getting rid of such heat would be a very slow process. The principal agency in this process would be heat convection, or the movement of the heated matter. There may have been radiation also, if the nebulous matter was transparent.

Such a loss of heat must have been most rapid at the surface, where gravity was greatest and radiation most free to act. The chilled surface matter, becoming heavy, would sink; the heated internal matter, becoming light, would rise. Thus there would be a double convection, that of heated matter upwards and of chilled matter downwards, and heat would be got rid of by both processes, being radiated from the surface, and also employed in re-heating the chilled matter. By a continuation of these processes the compressing effects of gravity must have made themselves more and more deeply felt, the resisting heat being gradually disposed of. Had the acting matter continued in the gaseous condition the above process might have continued until compression was fully produced internally, and there was a regular increase of density downward to the centre.

But long ere this result could have been reached surface solidification very probably took place, with the result of cutting off the distribution of heat by convection and radiation from the interior, and leaving only the interminably slow process of conduction. Therefore if the full effect were not produced before this solidification took place, it would be interminably delayed. And another delaying influence

would be the following :—If the compression of gravity first condensed the region of matter adjoining the surface, and yielded sensible heat, which heat was distributed to regions containing less sensible heat, this would take place as well towards the region of lower temperature at the centre as towards that at the surface. As a necessary consequence the central region must have grown hotter instead of cooler, and rarer instead of denser. And long ere this effect could have been reversed by the gradual approach of condensation to the centre, the solidification of the surface was probably produced, and the ready outflow of heat prevented.

The argument often advanced of late, that as solid matter was formed it would sink to the centre, and thus gradually produce a solidified core, does not seem well founded. The descent of this solid matter would be opposed by friction with the interior gas, while its weight would decrease as it descended. The decreased pressure and increased temperature to which it was exposed interiorly would tend to revapourise it. Long ere this process could have carried condensation to any extreme depth the local formation of solid matter at the surface would most probably have become general, and a continuous shell of solid matter have embraced the earth. The rapid radiation from the surface undoubtedly tended to produce this effect long ere the full results of compression could have been felt interiorly. In the present condition of the sun we have an illustration of this earlier stage of terrestrial evolution. In the solar orb the sensible heat yielded by the growing compression of the interior substance comes to the surface by a rapid convection, and is rapidly radiated outwards. Reversely, the dark spots seem regions of downrush of the condensed surface substance. Such a process must continue long after the surface condensation becomes sufficient to produce local solidity. Yet as interior compression becomes greater the convective action must become less rapid, and the outflow of sensible heat less active. Also increased compression must decrease the facility of descent of solid matter. Consequently the surface condensation must grow more declared as it is less hindered by upflowing heat, and solidification in time become general.

This effect must eventually be produced in the sun. It has, since a remote period, been produced in the earth. When once the solid shell had attained a certain thickness and rigidity it must have become permanent, and the outflow of internal heat have been, in great measure, confined to the slow process of conduction through this solid material. As the solid surface became thicker and more rigid its

pressure on the interior gas would be reduced, and might, in time, come to just equal the resistance of this condensed gas. That point once reached, compression by weight of the solid surface would not continue. The gaseous interior might yet contain considerable volumes of sensible heat, the result of previous compression. If this existed in regions intermediate between surface and centre it must move in both directions. It would be conducted upwards, and escape by radiation into space. It would be convected downward, and tend to increase the rarity of the central gas. There must, in fact, be a constant effort to produce uniformity of interior temperature.

The gradual loss of heat by the layer of gas in contact with the interior solid surface might act to produce liquefaction or solidification of this layer, and the thickness of the crust be thus increased. But such a process could be but temporary, since it would tend to rarify the remaining gaseous contents of the earth's interior. Such a rarefaction would act to convert sensible into latent heat. Hence the solidification of a portion of the gas would necessarily reduce the temperature of the remainder, and this might continue until the general temperature of the interior gas and the solid shell became uniform. This condition attained, there could be no further solidification of the gas, except as a result of a gradual cooling of the whole system. The refrigeration of the gas produced by this loss of sensible heat would not affect its physical condition, since its absolute heat contents would remain the same as before.

Yet the fact that a rigid solid shell was formed would not necessarily hinder a continuance of processes in the interior similar to those already considered. The globe of interior gas would in some respects resemble the original globe of nebulous matter, and gravitative compression might go on in it independently of the fact that it is surrounded by a solid globular shell. But the special conditions surrounding this gaseous globe would be markedly different from those surrounding the original nebula. The free radiation from the surface of the latter would be here checked, and reduced to a slow conduction through the solid shell. Thus the heat product of compression could be but slowly disposed of, and condensation could proceed only very slowly. It may be supposed, however, that it would continue until gravity had produced its full effect, and the gas had become regularly denser downward to the centre. But it must be borne in mind that the action of gravity here would also be greatly modified.

The effect of gravity on the surface matter of the original nebula was almost wholly centripetal, the material of surrounding space being too rare to strongly attract it. If now we take the conceivable case that the original nebula was at one time of practically uniform density throughout, the centripetal gravity of the matter of this nebula would necessarily decrease regularly from surface to centre, there being a reverse attraction upwardly at every point below the surface. The first effects of compression would necessarily be superficial, and would at once modify this uniform decrease of gravity. The condensed matter would grow heavier in proportion to its density, its increased downward pressure overbalancing the upward attraction. Thus the first effect of compression would be to remove the region of greatest centripetal gravity to that point in the interior at which the increased weight produced by condensation was just balanced by the increased effectiveness of the centrifugal gravity. This point would descend more and more deeply as condensation descended and grew more effective. But the disturbance of the original uniformity of gravity thus produced would be accompanied by a disturbance of an opposite character. As the gravity at any internal point must be determined by the vigour of centripetal gravity diminished by the vigour of centrifugal gravity, it follows that, as the surface layer became condensed, the centrifugal gravity increased in vigour. Thus the layer of rare matter adjoining that of dense matter had its centripetal gravity, or its weight, decreased. And this disturbance must have made itself felt, with diminishing effect, to the centre. If we take a portion of matter anywhere in the interior, this would experience two increments of attraction,— one from the matter laying between it and the nearest surface, the other from the matter in the line passing through the centre to the farthest surface. While all this matter was uniform in density, the vigour of these two lines of attraction would depend strictly upon their length. But when the matter at the two ends of the line— or the two surface regions—became condensed, these two portions of the line would exert increased attractions, in proportion to their density. But, under the law of diminution of attraction with distance, this increased attraction of the near surface would considerably overbalance that of the distant surface. Therefore, with every increment of surface compression, the downward attraction of every portion of the rare interior matter must have decreased, this decrease making itself felt to the centre.

Pursuing this thought we can readily conceive of a marked

result of such a process. One of its effects would be to diminish the rapidity of internal compression, so that the surface region may have become greatly condensed, or even solidified, to a considerable depth, while the reduction of gravity and the resistance of temperature kept the interior substance in the state of a rare gas. But as the superficial region grew denser the centrifugal gravity of the portion of gas adjoining it internally must have augmented, until in time it may have equalled the centripetal gravity. We would have the case, in fact, of a mass of matter in contact, on one side, with a thick region of dense matter strongly attracting it upwardly; and, on the other side, with a much thicker region of rare matter, attracting it downwardly with comparative weakness. And this rare region would be complemented, at a very considerable distance, with a dense region equal in thickness to the first, but so much more distant as to greatly reduce its attractive effect upon the mass of matter in question.

In consequence, it is not difficult to conceive of a process of terrestrial evolution somewhat as follows:—Compression of the nebula necessarily first took place at the surface. As it extended inwardly the heat set free hindered its rapid extension. The attraction of this dense surface region upon the interior gas reduced the centripetal gravity of the latter, and possibly, at length, completely negatived it. It may, indeed, have gone further than this. It may have reversed the gravity of the matter adjoining the inner surface of the dense surface shell. Instead of gravitating downwards, the matter in this region may have commenced to gravitate upwards, the effective attraction of the adjacent dense matter overbalancing that of the interior rare matter and the distant dense matter of the opposite surface.

In such a not inconceivable condition of things there would be a most effective hindrance to the inward extension of density. This, at first hindered by the resistance of temperature, became also hindered by a growing reduction of the downward gravity of the interior substance. Eventually this downward gravity may have become first negatived, and then reversed, it being replaced by an upward gravity. Going downward from the surface we would first pass through a region of downward pressure. At a certain depth this would reach its limit of effectiveness, the extra weight produced by increased density being balanced by the reverse effect of upward attraction. Going still deeper, the effect of this upward attraction must augment, and the downward gravity decrease. This decrease must regularly continue

until, at a considerable depth, the two increments of attraction may become equal, and a region—or a spherical shell—of no effective gravity be reached. Beyond this region the gravity may possibly become reversed, and the pressure of matter be upwards, instead of downwards. Going still deeper, and entering the gaseous region, this reversing influence would gradually diminish with descent, as the neighbouring dense matter was receded from, and the distant dense matter approached. Finally, at the centre, another region of no gravity would be found, the opposite attractions being again balanced.

Thus there would be a surface shell of downward gravity, at first increasing, and then decreasing to an interior limiting shell of no effective gravity; beyond this a deeper region of upward gravity, which again, after reaching its limit of effectiveness, slowly decreases, and merges in a second region of no effective gravity at the centre. Of course this hypothesis rests on the assumption that the earth consists of a thick shell of solid matter surrounding a, perhaps much thicker, gaseous interior. In such a case the deductions above presented seem beyond question. And that such is the interior constitution of the earth the necessary behaviour of heat in a condensing nebula certainly renders probable.

If condensation was confined to the superficial region until considerable density was produced, there would certainly be a reduction of the centripetal gravity interiorly. And if the superficial condensation reached a certain degree ere making its effect felt in the deep interior, then the gravity of the rare material adjacent to the inner dense surface must necessarily be so reduced by upward attraction as to be finally negatived. But compression would not cease with the production of this region of no effective gravity. Although no longer aided by gravity, the pressure of the dense material above must still have made itself felt, and produced condensation below this point. This would tend to produce the reversal of gravity above considered, and gravitative compression would now be upward instead of downward. Its tendency, therefore, would be not to augment, but to decrease the centripetal downward compression of the interior gas, and there must result a compression proceeding from centre to surface, not from surface to centre. The gas would become densest at the region adjoining the solid crust, and rarest at the centre. But such a process could not indefinitely continue. The growing rarity of the remaining gas as a portion of it became condensed, and its decreasing temperature in consequence, must necessarily act as a limiting check to condensation, and yield a final equilibrium.

In such a manner the earth may have reached, or may eventually reach, its final state of condensation, this increasing downward to a certain distance from the surface, and thence decreasing to the centre, and being at every point in accordance with the effective gravitation, the pressure, and the physical state of its material at that point.

The above considerations lead to some thoughts on the constitution of atoms. It is certainly not unreasonable to conclude that in the formation of atoms the same laws of fluid aggregation are obeyed as display themselves in the formation of suns and planets. There can be no question of great and small in the operation of natural laws, though differences in physical condition between great and small might produce certain differences in results. Thus the effects produced by solidification in great masses would not display themselves in minute masses. So the heterogeneity of great nebulous masses might be replaced by homogeneity in minute masses. These differences might produce differences in results, but under like conditions the law of aggregation must act uniformly, without distinction of great or small.

In a completely homogeneous nebulous mass condensation must proceed uniformly ; there could be no minor centres of aggregation, and no rotation of the mass, since every tendency to produce rotation in any one direction must be counteracted by an equal opposite tendency. In a heterogeneous mass minor centres of aggregation must display themselves, and the tendency to rotate in certain directions must overbalance that in others. It may be well to remark here, also, that all these processes would proceed simultaneously, so that the formation of the various bodies of the Solar System—as considered in my paper in this Journal for May, 1881—must have been simultaneous, instead of successive, as commonly considered.

The secondary centres of gravity in the original solar nebula affected gas volumes of the greatest diversity in size, from the planet down to the atom. The subordination of each such aggregate to the greater aggregate of which it formed part was an external, not an internal one, and it is very probable that the same principles of aggregation affected alike the sun and the atom.

We may imagine several modes of atom formation. In the case of its arising through the centripetal attraction of a mass of matter, this matter might be homogeneous and might be heterogeneous in density. In the former case all

the matter would condense directly upon the centre, and no rotation could arise. In the latter case the centre of gravity affecting each particle would not be the centre of mass. There would be motion tangential to the centre, and stronger on one side than on the other, and rotation must arise. This might develop two species of atoms, a rotating and a non-rotating. But the latter, most probably, could not retain their aggregation, since they could present no elastic resistance to the impacts to which all atoms are constantly subjected, and they must therefore be exposed to disintegrating forces.

But there is still another mode in which atom aggregation may have taken place, and this perhaps the most effective, if not the only, mode. In short, each atom may be a minute eddy, whirlwind, or cyclone in the ether. In the motions of the atmosphere it frequently happens that two opposing currents of air meet. Unless in the improbable contingency of this opposition being exact, their effort to pass each other results in a rotation, of which we have a familiar instance in the small whirls of air which so frequently arise. Similar phenomena are common in water, the meeting of any two diverse currents producing a revolving eddy. In fact, this result of the movement of fluids is a very common manifestation, and varies from the great whirl of the cyclone to the minute whirl of the air or water eddy. But the ether is a fluid affected by incessant motions. Minute winds of ethereal matter may be constantly moving in every possible direction. Such winds must constantly meet each other, and the inevitable result must be an eddy, or minute revolution of this fine fluid. But the eddy here may be ordinarily of such minute radius that the general centripetal attraction of the moving substance may suffice to retain its organisation. In short, a revolving mass thus formed may persist in this condition through the influence of the mutual attractions of its substance. It would compose a permanent atom.

If, then, we consider an atom as a mass of disintegrated matter, condensed about its centre of gravity, and rotating about a central axis, it would closely resemble the general conditions existing in a planet. But aggregation could not proceed so far as in the planet. The mass must continue gaseous. And the relations between its rapidity of rotation and its vigour of condensation might be far different from those existing in the planet. If the centrifugal energy of rotation was great as compared with the centripetal energy of condensation, the mass might assume a discoid shape,

the most effective energy of gravity being in the line of the axis. The same results must arise as in the case of a planet. The region of greatest gravity would be originally at the surface, but would extend inwardly as compression was produced. But at a certain distance inward a limiting region would be reached at which upward and downward attraction was balanced, and the mass would grow more rare from that region to the centre. Also the centrifugal energy of rotation, by its resistance to gravity, would tend to bring the region of greatest compression nearer the surface. In short, if the energy of rotation was considerable as compared with that of condensation, the original globular mass might become a flattened disk of condensed matter. From the surface region of greatest condensation matter would become more and more rare to the centre, and also more and more rare outwardly, shading off into the exterior disintegrated matter.

There could be no sharp lines of demarcation as between the solid and gaseous surfaces of the earth ; but the atom would be represented by a gaseous earth, with a region of greatest compression, and a rarity increasing regularly to the centre and regularly outward to the atmospheric limit. Its vigour of rotation must also decrease outwardly, and gradually shade off into the motion of free exterior matter, as in a former paper I have supposed the atmosphere of the earth to do. In short, I suppose an atom to be an exact analogue of a gaseous earth in which the utmost possible effects of gravitation have been produced, whose substance shades off into, and is practically continuous with, that of interspace, and whose motion of rotation gradually decreases outwardly through friction, as the energy of the centripetal attraction is reduced by distance, until finally all motion of rotation is lost. The atom would differ from the earth principally in having no inter-condensation of its material, it being an aggregation of disintegrated instead of integrated matter.

Assuming that what is usually called Ether is simply disintegrated matter, the atom would be a rotating aggregate of condensed ether, with an atmosphere shading off into the rare ether. Between atoms, as between spheres, there would be a region of free ether. And the possible quantity of atom formation must be governed by the same laws that limit spheral aggregation. For the condensation of ether into atoms must yield sensible heat on the same principle as in the condensation of atoms into spheres. This condensation of a portion of the ether must also rarify the remainder, and

reduce some of its sensible heat to the latent state. Temperature equilibrium would be disturbed, and could only be restored by the outflow of sensible heat from the atom to the ether. As a result the density of the former would increase, and that of the latter diminish. This action might be almost instantaneous, but its effects must be the same as in the case of larger bodies; it must limit the degree of atom formation. As atoms were formed the adjacent ether must have grown rarer, and its absolute heat have increased, until its centrifugal exceeded its centripetal energies. This relation between atoms and ether once attained, no more atomic aggregation could take place.

As atoms aggregated into molecules, and these into spheres, the ether between them must have been forced out, and have flowed into interspace. But the vast volumes of sensible heat produced by this secondary condensation also flowed into interspace. Through its action the centrifugal energy of interstellar matter must be increasing, and a reverse process of disintegration taking place there, atoms being reduced to the ethereal state until the necessary relations of equality between centripetal and centrifugal energy are reproduced.

Matter is practically continuous; but it cannot be really continuous unless ether have elastic properties enabling it to swell and fill vacancies. Except in this improbable contingency there must be voids left as matter condenses. But these voids are practically occupied by moving matter, the centrifugal energy of ether, as well as of atoms, keeping it in constant activity, so that no such void could remain empty more than an immeasurably small interval of time. The vibrations of light which pass through ether may pass through atoms and molecules as masses of ether. If accordant with the pitch of the atom or the molecule, they are absorbed. If accordant with the pitch of the atomic ether, they are transmitted. If discordant with either, they are repelled.

As we have spoken of the elasticity of a rotating atom, and the lack of elasticity in a non-rotating atom, it may be well to close with a brief consideration of this subject. Rotating atoms might be perfectly elastic. The particles would retain their lines of movement around the centre with considerable vigour. If driven from these lines, all the energy of the central force would aid in regaining them. The side of an atom, for instance, might bend deeply towards the centre under the influence of a blow, but the curve-preserving energy would force it out again, and thus

repel the striking substance with a vigour equal to that of the blow. This may be the secret of all elasticity—this forcible preservation of lines of movement under the influence of the attraction to which they are due. The elasticity of liquids may be due to movements of rotation; that of solids may arise from the forcible preservation of their lines of vibrating movement. The more rigidly these are retained, the more elastic the solid. But when the particles are not held with an attractive vigour sufficient to draw them back to the points from which they are driven, the solid becomes inelastic. When particles freely assume new lines of movement, elasticity ceases.

II. MINIATURE PHYSICAL GEOLOGY.

By C. Lloyd Morgan, F.G.S., Assoc. R.S.M.

(Concluded from page 640.)

VIII. *The Cutting Backwards of Rivers.*

THE ordinary typical river forms and deepens its valley by a combination of two processes, cutting downwards and cutting backwards. It is interesting to note how closely the two methods are connected. At first sight, indeed, it would appear that most valleys are almost entirely produced by the river cutting downwards. But a little further thought enables us to see that this very action is produced by the *fall* of the river, for if there be no fall the stream ceases to flow; and it is this fall of water that causes the cutting backwards. It is convenient, however, to keep the term 'cutting backwards' for the case of a river forming its valley or ravine by means of a waterfall.

The most notable example of this on a large scale is, of course, the formation of the Niagara ravine, some 7 miles long and about 166 feet in height, which stretches from Queenstown to Niagara Falls. The water of the Niagara River falls over a ledge of limestone. Below this limestone is a shale which—being easily decomposed and readily acted upon by the spray that is continually rising from the Falls, aided, I have no doubt, to a great extent by the action of frost—is rapidly undermined, until huge blocks of the lime-

stone above, being no longer supported, break off and dash to the base of the Falls. It is partly owing to the fact that the shale is undermined in this way that it is possible to walk for some distance under the Falls. When I was at Niagara it was not possible to go very far, but the scene was sufficiently striking. It was winter, and all the edge of the waterfall was fast locked in the icy grip of frost. On looking up, therefore, I saw hanging above me festoons of icicles, some of them a hundred feet long. With difficulty—for the rock was glazed with ice—I proceeded still under the Falls, and then, on looking up, I saw that which I shall never forget: the whole river took its mighty leap, and fell with a bewildering roar at my very feet. Though almost blinded by the spray, which froze to my hair and beard, I could not take my eyes from the curving green mass of water which shot over my head. In ten minutes I learnt a lesson concerning the power of water that the reading of a lifetime would not have taught me.

Of this cutting backwards, which in the case of Niagara is at the average rate of nearly a yard per annum, it is not difficult to find miniature examples. In a note-book, for instance, I find the following:—"Near Reculver, in Kent, a small stream is led through pipes from the Coast-guard Station to the cliff. This stream has formed a little valley by cutting backwards. Between a ploughed field and the edge of a cliff there is a band of about 2 yards of grass. The little valley formed by this stream has cut its way backwards through the grass, and for a distance of some 6 or 8 yards into the ploughed field. The whole has evidently been effected so recently that it forms an instructive example of geological action on a small scale." Below the waterfall, again, at Black Gang Chine, Isle of Wight, the little stream falling from a thick ledge of hard sandstone, over softer, more friable sandstone, affords a good small scale illustration of the action of the water at Niagara. On the way up Table Mountain, once more, above Bishop's Court, when the first ridge or terrace is reached, the path passes a miniature example of similar action, the place of the upper ledge of limestone being in this case taken by matted grass.

IX. *The Formation of Deltas.*

On the Ramsgate sands many of the miniature rivers flow into pools which are miniature seas or lakes. "I have often seen one of the streams in the course of an hour fill up a considerable bay, and push its delta far out to sea. The

grains of sand, when they come to rest in the pool, form a slope of very constant angle, which by a number of measurements I found to be 40° for coarse sand and 34° for fine sand, the average angle being 36°."—("Nature," March, 1878.) I have repeated these measurements on miniature deltas on the Cape Flats, and found similar angles. One of my notes on these miniature deltas is to the following effect:—"The delta seems to push further and further out into the miniature sea, until at last it has formed a long low spit. If now a little freshet comes down, the stream overflows to some extent its own delta, and ere long forms at one side of its original course a fresh channel, which leads to the sea by a shorter course." I was not aware at the time that I wrote this note that a similar action occurs on a large scale. In Mr. Belt's interesting "Naturalist in Nicaragua," however, I find the following passage:—"If the Colorado were not to be interfered with by man, it would, in the course of ages, carry down great quantities of mud, sand, and trunks of trees, and gradually form sand-banks at its mouth, pushing out the delta further and further at this point, until it was greatly in advance of the rest of the coast; the river would then break through again by some nearer channel, and the Colorado would be silted up, as the Lower San Juan is being at present. The numerous half-filled-up channels and lagoons throughout the delta show the various courses the river has at different times taken."

X. *Miniature Drift Currents.*

Below the chalk cliffs between Ramsgate and Margate there are, at low water, long pools, in which I have sometimes watched with interest the formation of miniature drift currents. "I remember watching with interest such a current, which flowed between tiny chalk cliffs through the straits which separated two miniature seas; the most instructive point being that the finer grains of sand at the bottom of the straits, where the water was some 7 inches deep, were rolling over each other in such a manner as to prove the existence of an under current setting in *the opposite direction* to that in which the surface current was flowing."—("Nature.") On a subsequent occasion I was able, by means of more or less loaded bladders, to see one near the top drift in one direction, another near the bottom drift in the opposite direction, while the third, sunk half-way, remained nearly stationary. At the leeward end of this pool there was a miniature delta, upon which the waves gradually

advanced, planing off the upper portion, and forming tiny cliffs of delta material, but leaving the deeper parts of the deposit intact.

XI. *Miniature Tides.*

When a little stream flows into the sea one may watch, as the waves roll in, estuary tides in miniature. The point with respect to these to which I directed my attention was, whether the tide as it came up "made" first along the shore or in mid-stream. But though it always did one or the other, and seemed always to do the same in the same stream, I am unable to say which is the more general. Nor can I say what causes bring about the one result or the other. I fancy that where the stream has shelving banks, and runs in a concentrated current, the tide makes along-shore; but that where the stream is wide, and widens out still more where it enters the sea, the tide makes up the main channel. This view, however, I cannot substantiate by observation.

XII. *Miniature Lake Terraces.*

On the sands near St. Catherine's Point, in the Isle of Wight, and again not far from Dolgelly, in North Wales, I have noticed the formation of miniature lake terraces. The only point worthy of notice with regard to these is, that they never extended individually more than half a foot or a little more in length, and that the terraces were at various heights. It seemed as if the formation of terraces was more or less continuous if the whole lake was considered, but intermittent if particular portions of the lake were regarded. This seems to me to help us to understand how a *series* of terraces, such as those which are found on the shores of Lake Superior, may be made by a *continuous* lowering of the waters of the lakes.

XIII. *Sand Ripples.*

On any extensive stretch of sands the way in which the sand-ripples are formed by the wind may be watched. It is curious to notice that a series of ridges is almost invariably formed. These ridges present a sloping face to windward, and an abrupt face to leeward. When it is blowing hard a quite remarkable sand haze may be seen quivering over the surface, as lighter sand grains are caught up by the wind;

and after bathing I have noticed a stinging about the ankles produced by the cannonade of little grains, the sand meanwhile being heaped up on the windward side of my feet. During a gale, and still more during continuous winds such as the 'south-easters' of the Cape, this sand cannonade must have some effect in eroding even hard rocks. That this actually *is* the case may be very clearly seen on the Cape Town side of Camps Bay, where the granite rocks have a very peculiar surface, eaten into deepish conical holes, which I feel sure have been produced in this way.

The sand-ridges above mentioned are constantly advancing in the direction in which the wind is blowing, but they are stopped by the smallest stream. I was struck some years ago, when I was in Cornwall, at the fact that quite a small stream stopped the advance of the sand dunes near Hayle, so that this stream formed a boundary between green grass flats and a wilderness of sand. This reminds one of Prof. Jukes's remark ;—"Egypt would probably have been long ago obliterated by drift sand, if it had not been for the Nile, and the strip of vegetation that accompanies and defends it."

Near Ouchy, on the Lake of Geneva, I had a good opportunity of seeing the formation of sand-ripples under water. My note on the subject runs thus :—"As each wave passed the little ridges advanced, the sand being raised in a small cloud up the sloping side of one ridge, over the intervening gap (falling down the steeper side), and being deposited on the sloping side of the next ridge. Thus the whole set of ridges advanced gradually."

XIV. *Miniature Earth Pillars.*

Those who have visited Switzerland or the Tyrol probably know well the nature of earth pillars. Those who have not perhaps know something about them at second-hand, through the pages of their Lyell. Such earth pillars may be seen in miniature almost anywhere. On the sea-shore a broken shell protecting the sand beneath it from the action of rain becomes raised on a little pedicel or miniature earth pillar. The sloping banks of the very ditches offer examples sometimes 2 or 3 inches high: these are, however, so well known as to call for no comment here. I may only mention that the finest miniature examples I have seen were on the Tijuca road, not many miles from Rio. They were in a decomposed granite slope, were capped by bits of less decomposed rock, and were about 9 or 10 inches in height.

XV. *Miniature Mountain Sculpture.*

On the south side of Hout's Bay, in the Cape Peninsula, one of the many little 'kloofs' scooped out in the granite shows at its head a curiously cut face of the rock, which is here easily decomposed. The head widens out to about 50 or 60 yards, and forms a sloping cliff of some 30 feet in height, at the top of which are oddly-perched boulders of much harder granite. This forms the upper end of the kloof, and is evidently working backwards year by year. It seemed to me to afford a miniature illustration of the carving out of a mountain face. In the granite the water has cut out a number of ravines, some broader, some narrower, which seemed only to want vegetation to make them perfect miniature kloofs. Between these projected buttresses, of perhaps somewhat harder rock, one of these ridges, when viewed from above, was seen to have a well-marked succession of shoulders; here and there were vertical faces ending in a steep slope. From the nature of the rock there were no signs of the terraces which form so marked a feature of the Cape Peninsula mountains, composed as they are of more or less even-bedded sandstone. Near the foot of the face there was one very marked rounded spur, running out at right angles to the head of the kloof. In fact, as I looked from the granite face, cut out as I have very briefly described, to the steep mountain slopes which here border Hout's Bay, I could not but be forcibly struck with the similarity of the two. And this steep face, be it remembered, has been formed by the action of atmospheric agencies and stream wash from a sloping hill face.

XVI. *Recent Fossilisation.*

Perhaps I may here be allowed to draw attention to the process of fossilisation which may almost be seen in progress in the blown sand of the opposite side of Mount's Bay, as well as near Kalk Bay and elsewhere, in the Cape Peninsula. This blown sand consists partly of sand grains, partly of the comminuted fragments of shells. In process of time it covers up such scrubby vegetation as lies in its path. Shut out from the light of day and from the air, this dies, and begins to decompose. But as each particle of woody fibre is removed, its place is taken by a particle of lime, taken up from an aqueous solution of the shell fragments. Thus bit by bit, molecule by molecule, the wood is

replaced by limestone, which preserves, in a state of greater or less perfection, the form of the decaying root or branch, and becomes a complete pseudomorph. This has gone on to such an extent that the sand is here and there strewn with these pseudomorphs, while it is not difficult to find calcified roots *in situ*, even the most delicate filaments being perfectly replaced by brittle limestone.

XVII. *Conclusion.*

I have set down these miniature observations in the belief that, trivial as they seem, they have some *educational* value. I am firmly persuaded that they and their like educe and develop faculties of observation, and thus throw the mind into a fit attitude for observing on a larger scale should opportunity occur.

III. THE POISONOUS POWER OF METALS.

M. CH. RICHET has been experimenting on the comparative poisonous power of different metals, by observing what quantity of each may be dissolved in a given volume of sea-water without proving fatal to fishes immersed therein in less than forty-eight hours. The maximum dose of each metal in the state of chloride, compatible with life for the time specified, he names the "limit of toxicity." The species of fish experimented upon were *Serranus Cabrilla*, *Crenolabrus Mediterraneus*, *Iulis vulgaris*, and *I. Geoffredi*. A previous set of experiments had shown that these fishes were capable of surviving for an indefinite time—*i. e.*, longer than eight days—in 2 litres of sea-water, placed in a wide crystallising pan, open to the air. M. Richet seems to have proceeded in the following manner:—Dissolving in the water a large excess of the metallic salt in question, and, noting how long the fish survived, he gradually reduced the dose till he reached a quantity which did not prove fatal. In all cases chlorides were used, since a special trial had shown that they were less poisonous than the corresponding nitrates.

The sulphates he rejected as being too sparingly soluble for such experiments. In this manner he worked through mercury, copper, zinc, iron, cadmium, ammonium, potassium, nickel, cobalt, lithium, manganese, barium, magnesium, strontium, calcium, and sodium, and found their toxicity decrease in the order here given. Thus whilst the largest quantity of mercury in the state of perchloride, compatible with life, was 0·00029 grm. per litre, in sodium the limit rises to 24·17 grms. in the same volume of water. Several of the most poisonous metals, such as arsenic, antimony, and lead, have not been experimented with.

The author calls attention to the fact that, according to his results, there is no definite relation between the atomic weight of a metal and its toxicity. Copper, according to his table, is 600 times more poisonous than strontium, though its atomic weight is less. Lithium, whose atomic weight is only one-twentieth that of barium, is still three times more poisonous. Even in metals of the same chemical group the relation between atomic weight and toxicity does not appear. Thus cadmium (atom. weight 112) is by one-half less poisonous than zinc (atom. weight 65). Lithium (17) is seventy times more poisonous than sodium (23).

The first point which strikes us in examining the results of M. Richet is their want of agreement with the conclusions reached by Dr. James Blake ("Journal of Science," 1881, p. 318). This experimentalist found that, as regards bodies belonging to one and the same isomorphous group, the higher the atomic weight the more intense is the physiological action. M. Richet finds no such relation, as may be seen from the last two instances given above. He declares also that there is no relation between the chemical function of a body and its toxic power, giving as an instance the experimental result that potassium is 250 times more poisonous than sodium.

But it would be, we think, premature to pronounce any decided opinion concerning these and other discrepancies which might be particularised. The methods of experimentation in the two cases are totally different. M. Richet, as we have said above, immersed his subjects in poisonous solutions, and simply noted the facts of death or survival, and the time in which the treatment proved fatal, if at all. Dr. Blake injected known doses into a vein or artery, and recorded not merely the fatal quantity, but the nature of the symptoms produced, and noted the curves described by a kymograph connected with the femoral artery. His researches, too, have extended to forty-one of the metals, and

have been continued for forty years. A point of difference not to be forgotten is that Dr. Blake operated exclusively upon mammals and birds, for which M. Richet's method would have been impracticable. The latter inquirer considers that by his immersion method "we escape the inconveniences due to the variable weight of the animal, and to the disturbing chemical reactions which follow on a sudden injection into the blood." We are by no means sure of such advantages. Without especial experiment—of which M. Richet makes no mention—it may be considered at least an open question whether a smaller subject might not succumb to a weaker poisonous solution than would a larger animal of the same species. It is also more than probable that the absorption of the various metallic salts into the circulatory system through the skin, and especially the gills, will vary quite apart from the poisonous power of each.

In the cases of iron, strontium, and barium, the author tells us that the sulphates and phosphates present in the sea-water were previously eliminated by means of a suitable quantity of barium chloride. This operation, he maintains, did not appreciably affect the vital conditions of the fishes submitted to the experiment. On this point we must plead guilty to a slight degree of scepticism.

The results obtained by M. Richet differ also from those obtained in general experience on the action of poisons introduced into the animal system by the alimentary canal. Thus the soluble salts of barium are, when swallowed, very powerful poisons. In M. Richet's scheme they rank as less formidable than the compounds of iron and potassium. Everyone knows that a method has been proposed for purifying "plastered" wines, by treating them with a quantity of barium tartrate proportionate to the sulphuric acid fraudulently introduced. The suggestion, theoretically very happy, has not come into any wide practical application, from the fear entertained by medical and chemical authorities that possibly from some oversight a little barium might remain dissolved in the wine. But if M. Richet's conclusions are of a general value we should find here little cause for alarm. In fact, on the author's scale, 5 grains of barium, in solution, would have only about the same injurious action as 10 grains of magnesium!

In one very important point M. Richet agrees with Dr. Blake, with common experience, and, we venture to add, with common sense. He finds that the idea of poison is not qualitative, but quantitative. In contradiction to the rash dogma that whatever is poisonous in a large dose is,

pro tanto, poisonous also in the smallest, he shows that, as far as his experiments extend, all soluble salts—including those naturally present in the blood and taken in our food—are poisonous if administered in a sufficient dose. This truth does not come as a novelty to scientific physiologists, but to no small number of semi-scientific writers and orators it will be both new and unpleasant.

We have a further remark to add: the method of M. Richet—the immersion of fishes in water containing known proportions of deleterious matter—has been independently, and we believe from an earlier date, made use of by an English experimentalist, although from a different point of view, under which it is the only process possible.

IV. THE ETHICS OF INVENTION.

By An Old Technologist.

BEFORE attempting an examination of the questions involved in this subject, I must, as a preliminary, settle the distinction between the loosely-used terms "discovery" and "invention," which again presupposes a recognition of the difference between Science and Industrial Art. This difference, in spite of the full light thrown upon it by Whewell, John Stuart Mill, Sir J. Herschell, Comte, and others, the British public refuses to grasp. We still hear steam-navigation and railroads, revolvers and torpedoes, the Jacquard loom and artificial alizarin, and even the performances of "Farini's *Zazel*" and the "eagle-swoop" of Maraz spoken of as triumphs of Science. Yet the distinction is most simple and natural. The object and purpose of Science is simply to know everything that actually or potentially exists: it examines their properties, their mutual relations, and, not content with asking *what* exists, it proposes and seeks to solve the questions *how* it exists and what has called it into existence! But all this is done without any reference to human convenience or wishes, without any attempt to apply the knowledge gained to any purpose, good or evil. The results of Science are expressed not in receipts or working directions, but in phenomena recorded and in theories demonstrated.

With practical art, or what is sometimes called "applied science," the case is totally different. The object sought is not the increase of knowledge, but the promotion of material convenience, comfort, luxury, and power. Truths ascertained are valued not for themselves, but in so far as they admit of or promise some application. To this end the facts and the laws ascertained by Science are carefully scrutinised. Still it is an error to suppose that Art is a necessary consequence of Science. On the contrary, it is probably the elder of the two. Industrial processes were carried out at first empirically. Continued attempts led to certain results, though the principles upon which such results depended remained unknown for ages. As an instance I may mention the process of Turkey-red dyeing, which has been successfully carried out for a couple of centuries, but is even yet scarce fully understood. Art and Science are not necessarily connected with each other, either in place or time. A country might be rich in such men as Newton, Faraday, or Darwin: it might make rapid progress in pure Science, and yet its outward material existence might be poor and stationary, and its high thinking might be accompanied by very plain living. Again, modern advances in Art are not necessarily connected with any modern development of Science. Take, for instance, the revolver, which a smart writer in a daily paper not long ago took occasion to characterise as "one of the questionable gifts of modern Science." So far is this from being the case that a weapon essentially the same was in being about three centuries ago!

Science and Art, then, pursue respectively distinct objects, and with distinct motives. Every step in advance taken by the former is a discovery; every movement effected by the latter is an invention. Now a discovery, as such, has no moral bearings. The desire to know is neither virtuous nor vicious; not even between the two, but standing altogether on a different plane. Nor does the possession of abstract knowledge in the least modify human character. Suppose—and it is a fairly strong supposition—that I should next year decompose our present elementary bodies, and present to the world something worth calling a new chemistry. Yet neither I, the originator of the new discovery, nor any of the multitudes of people who would hear of it, fix it in their memories, examine the evidence on which it rests, and incorporate it in manuals and hand-books, would be morally one hair's breadth the better or the worse. But an invention has, or may have, a moral phase. It does something that was not done—could not be done—before, and that something

may be good or evil. The inventor, or would-be inventor, is therefore in duty bound not to overlook this question:— Will my invention, in its general and preponderating tendencies, be good or evil? Let us take a few instances. There is the Gillwell drying-machine, for securing the hay- and corn-crops in unfavourable seasons, as described in the October number of this Journal; there is the invention of Thomas and Gilchrist in the iron manufacture; the Le Blanc process for alkali-making; the various inventions for obtaining valuable products from coal-tar; there is the Nesbit process for rendering it impossible to tamper with cheques after filling up; and numbers of others which, whilst they increase the wealth and the resources of mankind, and give remunerative employment to multitudes of persons, do not put any new weapons into the hands of persons at war with society, whether such be criminal individuals, criminal associations, or criminal races. In all such matters there is no reason for the conscientious inventor to desist from experimenting in any particular direction, or to suppress results at which he has arrived. On the contrary, such inventors, whatever emoluments they may secure individually, confer far greater benefits upon their fellow-men, and may justly be regarded as having deserved well of the world. But there are other inventions, well known and important, where the benefits accruing are not without a serious counterpoise. As an instance of this kind let us take the lucifer match. Has not every rhetorical extoller of the present and contemner of the past pointed his moral and adorned his tale with these fizzing and somewhat evil-smelling emblems of progress? Nor am I about to call in question their fairly recognised advantages. There are conceivable cases where the life of a useful member of the community may hinge on the power of instantly procuring a light. But *per contra*. No one can deny that the "lucifer" has greatly smoothed the paths of crime. The rick-burner or other incendiary need not, as in the olden time, equip himself with flint and steel and tinder-box, and stand hammering away in a cold winter's night till he can secure the wherewithal for setting light to stack or barn. A simple box of matches saves him all this time, trouble, and risk of detection. The burglar need scarcely encumber himself with the proverbial dark lantern. Nor is this all: the match-manufacture, as hitherto carried on, undermines the health of no small number of people, and certainly withdraws a serious quantity of phosphorus from its legitimate duties as phosphoric acid in our fields and gardens. So that, in fine, though the good

produced by lucifer matches would probably outweigh the evil, yet there is a balance to be struck; and in any similar case it is, in my opinion at least, the duty of an inventor to weigh well both sides, and consider the consequences.

But I will pass to an instance where, I think, not the shadow of a doubt can prevail. A few weeks ago a paragraph was going the round of the papers concerning a marvellous invention said to have been made by an Austrian chemist. It was said—and whether truthfully or falsely it will for my present purpose matter little—that this man had invented a liquid compound which if flung upon a man deprived him instantly of all power and sensation, in which state he must remain till death unless restored to animation by a second liquid, also discovered by the same genius. I will pass over certain elements of improbability which on careful examination will appear in the story. It was then further alleged that the inventor had offered his secret to the Imperial Government, but instead of the hoped-for reward he had been commanded to destroy all memorials and records of his process, and to refrain from revealing it under appropriate penalties. Now let us suppose such an invention really made and revealed: the necessary result would be a perfect carnival of outrage. No man's life, no woman's honour, no property could be safe. The advantage of such a weapon as this fluid would be all on the side of the wrongdoer. Meeting any stranger in a lonely place, the only safety would be to shoot him down before he came near enough for the possible use of this diabolical compound. Suppose a respectable citizen walking home in a dark night: instead of the "stand and deliver" of the old footpad, or the hug of the modern garotter, against each of which a safe defence is conceivable, he would find himself without any warning asphyxiated, and would be plundered at leisure and left to die,—die, too, without any marks of violence to arouse suspicion. Or suppose any of my readers sleeping the sleep of the just in his own dwelling: a burglar, armed with this newest weapon, enters stealthily and bedews the face of the sleeper, whose "heart but once heaves and for ever turns chill." Against all these possible evils, which await nothing but the actual realisation of such a discovery to be rendered horrible realities, there would be but one set-off—the ease which such a man provided with this liquid could dispose of a tiger, a lion, or a grizzly bear. But this advantage would be far too dearly bought, at the price of putting such an irresistible weapon into the hands of the criminal class. Should any person accidentally come upon such a compound

it would be his most sacred duty to keep it an absolute secret, and the obvious policy of Society towards a man possessing such an invention would be to take one of the only possible guarantees for his silence.

But there are other inventions which, if not yet achieved, are eagerly aimed at, the effects of which would be scarcely, if at all, less dreadful. I may turn, in the first place, to aërial navigation. Not merely individuals, but associations, in different countries are busily engaged in planning, calculating, and experimenting, with a view to sooner or later travelling through the air. But no one takes the trouble to estimate the probable results, should success crown the efforts of these enthusiasts. Says one of the characters in Rasselas—"Were all mankind good and virtuous, I would with great alacrity teach them to fly." But in our days, as in those of Dr. Johnson, all mankind are very far from being good and virtuous. Nay, without asserting that the human race has grown more wicked, which may or may not be the case, it may be safely asserted that crime is now better organised, more intelligent, more on the alert to take advantage of modern improvements in the arts, mechanical, physical, or chemical. I will admit that the power of aërial navigation would be on some occasions and in some respects of exceeding value. I will take as an instance the exploration of unknown regions. Deserts, swamps, regions inaccessible from cold, would be no obstacle to the traveller, who, gliding along, could map out at his ease the country beneath him. Africa would soon have to surrender her remaining secrets, and the Polar regions would soon be as completely known as Switzerland or Norway. All this is an exceedingly tempting prospect, and I can scarcely wonder that those who do not take the time and the trouble to examine both sides of a question should become almost intoxicated at the very idea. And what is here the other side? Nothing more or less than that all the natural features and all the artificial appliances which from the prehistorical ages down to the present day have served to shelter individuals and nations from their enemies would be swept away at a stroke. Aggression would be indefinitely assisted, defence rendered almost impossible, and everyone who has anything to lose would be placed at the mercy of greed, of malice, or of a wanton disposition to injure!

This picture may seem at first sight overdrawn, but on close and calm examination it will be found correct to the smallest detail.

Let us suppose flying-machines invented, manufactured,

and offered for sale. A Peace of the days to come will find no more difficulty in purchasing such an appliance than he now has in buying ammunition or revolvers. Thus equipped he can sail through the air to the bank, the warehouse, or the mansion he means to plunder. What will it matter that all outer doors, all accessible windows are secured? Some upper window, some skylight, some weak point in the roof, or entrance leading to an inner court, heretofore inaccessible, will generally be found where the enterprising burglar may gain admission with little need for the tools of his trade. There will be a further advantage: at present the robber, going along the streets at night with his jemmy, his skeleton-keys, &c., is at once an object of suspicion, and is liable to be arrested on the mere fact of being found in possession of such implements. Again, suppose him in the present day, after a successful foray, going back to his den with a bundle of silver plate or other valuables on his shoulder. He is liable to be watched, followed, and seized. But his successor, thanks to "progress" and lovers of aërial navigation, will encounter no such difficulties. He will come and go unseen, his tools and his booty snugly reposing in his flying chariot as he sails along right over the head of the unsuspecting policeman. No one will have seen any suspicious-looking stranger in the neighbourhood. The deed being done, he may wing his way to San Francisco or Cape Town, to New York or Sidney, and there dispose of his plunder. It must surely be plain that the chances of detection after the deed would be reduced in as great a proportion as the facility of entering premises would be increased. Or take the case of murder: the intending assassin may arrive unknown at the place where his intended victim is staying, and may be gone before his presence has been even imagined, there being little more reason to suspect any one of the fourteen hundred million inhabitants of this planet more than any other. I would now ask—Are our appliances for the frustration of crime, and for its detection when actually committed, so superabundant, so more than equal to their task, that we can afford to give it such an immense additional advantage? That flying machines if once made could be confined to safe hands would be too much to hope. That the criminal class would feel any hesitation or reluctance to avail themselves of the new resources thus bountifully placed in their hands is unthinkable, especially if we consider how readily they have taken to the revolver, to chloroform, &c. Indeed our criminals seem far more alive to the value and possible utility of a novelty than do our manufacturers and merchants.

It may surely, then, be asserted that every man who has anything to lose has a deep interest in the non-success of the present attempts at aërial navigation.

But I must proceed further. In addition to the private criminal or the gang of criminals we have now what is facetiously called "private warfare" waged by secret societies against Governments. Easy-going simplicity is apt to fancy the leading spirits of such associations as loftier in their motives, and therefore entitled to more consideration, than the pirate or the brigand. A shrewder judgment will scarcely accept this view. Be this as it may, such societies would find the flying-machine solve all their difficulties. No fear would exist of their infernal machines being discovered by the officials of the customs or the police. Not to speak of what would ere this have happened at Berlin or St. Petersburg, where the sport of emperor killing would be much facilitated, it can scarcely be doubted that if the art of travelling through the air were known, London would before this have been in great part reduced to ruins and ashes. Surely a heavy price to pay for the facility of visiting the North and South Poles!

We now come to the third and last phase of the influence of aërial navigation, whenever effected,—that is, the modification which it would introduce into warfare. We in England have been hitherto in great measure protected from the worst horrors of war by the "silver streak of sea" interposed between us and the Continent. Large rivers, chains of mountains, and fortifications have hitherto frequently enabled nations to make head against a more numerous invader. All such defences, natural or artificial, would be at once sacrificed if the flying-machine becomes a reality. The nation which has the most numerous army, and which is constantly planning aggression, would be strengthened, whilst those nations who merely stand on the defensive would be weakened. It must also appear that when war is waged by sending flying-machines to hover over the cities of an enemy, and to let fall shells filled with nitroglycerine, the advantage will be all on the side of any country which has a scanty and scattered population, with little wealth stored up in any one locality. On the other hand, the richer, the more populous, and industrial a country, the worse it must fare. Suppose the French and the Tunisian Arabs each furnished with these appliances. Certain it is that the Arabs could inflict a hundredfold greater damage upon France than the French could upon their wilds and deserts. I have indeed met with a man

vehemently opposed to war as an unmixed evil, and yet, paradoxically enough, a perfect enthusiast for aërial locomotion. He freely admitted that railways, telegraphs, and other appliances which it was once hoped would fuse mankind into one peaceful brotherhood, had by no means had such an effect, and had even been utilised for the purposes of an invader. Still he hoped that with aërial navigation the case would be different, and that even if the horrors which I have attempted to point out should be realised, we of the present day ought to bear them contentedly, in the hope of some fancied "good time coming." Are my readers so devout in their worship of pseudo-progress that they will risk the utter overthrow of civilisation?

Somewhat similar in its tendencies and possible results is the proposal of submarine navigation, which is also a pet idea of my peace-loving friend.

I would ask now whether it is not a solemn duty on the part of inventors to turn their energies in directions where at all events there is no fear of promoting crime, treason, and aggressive war? All the inventive genius of our race might be exerted for a thousand years to come on subjects quite as remunerative for the individual, and much more advantageous to the public, without any such drawbacks. Are there not diseases and noxious animals to extirpate? Is there not the synthesis of plant-food and perhaps of human food from inorganic matter to be effected? Are there not summer rain-clouds to be dispersed, and cloudless night-skies in spring to be overcast? Are there not new sources of energy to be discovered, that we must needs employ our time and talents in playing into the hands of crime?

V. THE RECENT "VIVISECTION" CASE.

A few days ago the scientific and especially the medical world were painfully startled by the intelligence that application had been made at the Bow-street Police Court for a summons against Professor Ferrier, under the so-called "Vivisection Act." The prosecution—it might possibly be contempt of court if we were to use a

more appropriate term—was, at the instance of the "Victoria Street Society for the Protection of Animals from Vivisection"—a body whose *animus* and whose funds may be estimated from the fact that they engaged three counsel, a Q. C. and two juniors, to apply for the summons, a task which could have been quite as well performed by a solicitor, at the cost of one guinea.

As a matter of course the astonishment excited by the painful news was great. It seemed incredible that a man of the well known standing of Professor Ferrier, needless and insulting as he must deem the Act, would put himself within the grasp of the law by any neglect or violation of its provisions. Surely, it was said, if the learned Professor found it necessary in the course of his researches to prove any point by experiment upon a living animal, he would have applied for the usual certificate. An eminent medical contemporary, indeed, remarked that as the "Society" in question had not yet been able to catch any experimentalist committing himself, they had come to the conclusion that they must at any rate prosecute somebody by way of satisfying that part of the British public which has been persuaded to supply them with the needful funds. Our own version of the motives of the prosecution—as will be seen below—ascribes better strategy to the Anti-Vivisectionists.

The case came on for hearing on November the 17th, and in spite of the three counsel and of a great expenditure of sophistry, collapsed utterly. The summons with, what outside of legal circles would be deemed gross mendacity, charged Professor Ferrier with "having *on August 4th and on divers other days thereafter*, performed experiments calculated to give pain to two monkeys, and in violation of the restrictions imposed by the above Act." For all this it was admitted by the prosecuting counsel that the experiments upon the monkeys were performed six months ago, and consequently not at the time charged in the summons! The experiments, if we may so call them, which took place on or about the fourth of August, by Prof. Ferrier, could not be considered painful or held to come within the scope of the Act at all. He offered a biscuit to one monkey, which it took with the left hand in proof that it was paralysed in the right hand. The other monkey had been rendered deaf by the operations performed months ago, and in proof thereof Prof. Ferrier snapped off a percussion cap, of which the animal took no notice. These were the "shocking and frightful" experiments! The facts are that the experiments upon the monkeys had been performed some months previ-

ously by Prof. Yeo, in strict accordance with the provisions of the statute, and that he had obtained a licence to keep them alive, in order that the results of the experiment might be observed. On the day in question, in consequence of a discussion at a meeting of the Medical Congress between Professor Ferrier and Professor Goltz, a number of eminent scientific men, among whom we may mention Prof. Huxley, went to King's College, when the monkeys were produced by Dr. Yeo's servant. Professor Ferrier's sole offence, therefore, if it can be construed as such, consisted in his observing and pointing out the effects of an experiment performed months ago, and that under perfectly legal conditions. Yet Mr. Waddy presumed to call this "being present and taking a leading part in experiments (!) upon an animal upon which an injury had been inflicted." Rarely has the licence accorded to counsel of presenting facts in a manner calculated and intended to mislead been carried to a greater length. It is not, however, so much upon Mr. Waddy as upon those by whom he was retained and instructed, that the responsibility must rest. But of this anon. The magistrate, Sir James Ingham, very rightly remarked, that if noting the results of a past experiment constituted an offence, all those present in the laboratory of King's College were equally culpable with Professor Ferrier. How utterly untenable the prosecution felt their position appears from the fact that, though offered a case for the Superior Court, they did not accept the offer, a significant admission on the part of a body with whom money is evidently no object.

One question relates to the witnesses, Dr. Michael Foster and Charles Smart Ray. We do not for a moment entertain any suspicion of these gentlemen, the former of whom has been recently elected one of the Secretaries of the Royal Society, *vice* Prof. Huxley, resigned. But we think they owe it to the scientific world and to their own reputation to state publicly, that they did not volunteer their evidence, but appeared under *subpœna*.

We come now to the impersonal prosecutor—the "Society for the Protection of Animals from Vivisection," and its Secretary, a certain Mr. Adams. This gentleman and his Council or Board, or whatever name it may bear, are placed in a very unpleasant position. We do not mean legally, for despite the maxim current among lawyers, that for every wrong suffered there is a remedy against some one, we fear that Professor Ferrier would have very slender prospects of recovering damages from the prosecutors. But we refer to the position which they must occupy in the

judgment of all save the ignorant and the fanatical. Either they knew beforehand the facts which were brought out in evidence or they did not. In the former case they stand convicted of having wantonly and gratuitously subjected a man to the indignity and annoyance of a criminal prosecution, knowing that he had not committed the offences laid to his charge. In the latter event, if they did not know the facts they are then guilty of bringing a railing accusation at hap-hazard. If the contention raised by the counsel for the prosecution is ever upheld, it will become dangerous to look at an animal upon which any experiment has been performed at some antecedent date even under licence; it will be dangerous to note and discuss the results. We must further take good heed of the extension which the same counsel has attempted to give to the connotation of the word "experiment." It is perfectly plain that for the purposes of the Vivisection Act this word means exclusively some process or operation, mechanical or chemical, calculated to occasion pain to an animal. Yet Mr. Waddy speaks over and over again of "experiments" of a very different nature. Thus he says "it was in contravention of the fourth section of the Act to keep the animals alive for the purpose of having other *experiments* performed upon them." "The animal was brought over for further *experiments*." "An adjournment to the laboratory at King's College for further *experiments*." Now when we reflect that these "experiments" on which such stress is laid, and for which it was contended that a certificate ought to have been obtained, amounted to the offer of a biscuit and the snapping off a cap in test of deafness, the whole proceedings might be justly proclaimed a farce if they were less disastrous for the defendant.

We cannot help pointing out how different and how much more dangerous is the position of a man accused of inflicting pain upon animals in the pursuit of knowledge than that of one who has put birds or beasts to torture for gain, for "sport," or for the mere love of wounding and killing. Let us take the case of a cock-fight—a pursuit utterly useless and illegal under any condition. It is possible that the owners and backers of the cocks or any other person actually present at the fight might have to appear before the nearest petty sessions. The prosecution, however, would be conducted, not by a Queen's Counsel and two juniors, but by some local solicitor. Consequently the defendants would not be put to the expense of engaging on their behalf a corresponding array of legal talent. This feature, indeed,

is one of the most unworthy of the whole affair. It is, in fact, as if Mr. Adams had said to Professor Ferrier, "Whether you are innocent or guilty I will at all events put you to as much expense as I possibly can!"

There is here another feature; in the case of a cock-fight or a bull-baiting, none but those actually present and taking part in the performance are within the reach of the law. Suppose a wounded cock had survived the fight, no person examining him some six months after would be liable to a criminal prosecution. Now if we consider how much more severe are the penalties for unlicensed vivisection than for those cruel "sports" which have won for our country so unpleasant a reputation throughout the civilized world, it might surely be demanded that the provisions of the Act should not be laxly construed.

We turn now to the "Vivisection Act" itself. In the year 1876, when this Act was under discussion, some of our medical contemporaries expressed themselves satisfied with its contemplated provisions. It was considered that there was no reason to fear that the proposed measure would "in any material way" diminish existing facilities for research, whilst, on the other hand, a hope was expressed that it would "calm the needless apprehension, and put an end to the odious misrepresentations which have been recently rife concerning this subject, and which have been in ignorance adopted by persons of consideration, who will probably in future take more pains to be correctly informed." In the "Journal of Science" for July, 1876, in an article which the anti-vivisectionists have prudently declined to answer, we declared that these expectations would come to naught.

Our words have been more than verified. The agitation, far from subsiding, has increased in vehemence and in venom. An esteemed contemporary admits that it has been "making steady progress among the emotional and ignorant classes of the community," who are, in effect, our rulers, and pronounces, as do we, the passing of the Vivisection Act unfortunate and unwise.

The question now arises how long medical men and biologists in general can find it prudent to continue the policy which they have adopted since the commencement of the anti-vivisection uproar? How long are we to allow ourselves to be systematically traduced in pamphlets, petitions, speeches, and prayer meetings, without combining for the defence of Science? We have met and more than met all the charges brought against us, but our replies have appeared merely in medical and scientific journals which never reach

the general public, and which are on principle ignored by the "honourable men" who conduct the agitation. Hence the outside world is naturally led to believe that the accusations against us are true, and that we have no defence to offer. The position is really more serious than many of us seem to understand. The hysterical party who are organised to crush Physiological research in Britain, or if possible, in the world, are supported by "persons of consideration," whose wealth is only exceeded by their ignorance of the true bearing of the question. In the press they are powerful. At least one daily paper and one weekly journal, both of which have the ear of the present administration, are plainly against us. So are all the "Society" organs and the so-called "Christian" papers, thus exhibiting the curious spectacle of an alliance between Vanity Fair and Little Bethel—fashion and frivolity leagued with puritanism to suppress scientific research. In the same cause we see ecclesiastical dignitaries fraternising with dog-fanciers and sport-loving squires. In short, a great if not a preponderating portion of the most powerful interests in these realms are arrayed against us. Further, our opponents are organised whilst we stand isolated and ready to be hunted down in detail. For this purpose our enemies—it is no use disguising their real position—need only go on as they have begun.

Professor Ferrier, though the summons has been dismissed, has, in our opinion, suffered grievous wrong, and wrong for which he can obtain no redress. He has been put to very heavy expense, and what is perhaps to a scientific man still worse, to loss of time, anxiety, and distraction of mind. He will be held up to execration on sentimentalist platforms, and doubtless prayed at by the Holy Willies of Edinburgh. It may, perhaps, strike certain Honorary Secretaries that if scientific men can be thus annoyed, even though the cases break down, the ends sought may be gained. It will be perceived that this Act which counsel —we suppose ironically—described as "made for the benefit of the medical profession," and "framed so that there should be no restriction of experiments in the interests of Science," is fearfully elastic. That it has failed in doing what was amiably, or we might say fondly, hoped by its promoters, that is, in putting an end to the sensational agitation, is patent. As the matter stands it seems that merely looking at or making any observations upon an animal which has undergone an operation subjects the observer or spectator, if not to a penalty, still to serious

annoyance. We must, therefore, beg to propose that action should be taken without delay. The first desirable step is to call a meeting of persons interested, in order to adopt an address of sympathy with Prof. Ferrier, and to originate a subscription for the purpose of re-imbursing him for the outlay to which he has been put. Secondly and principally, a Biological Defence League should be immediately organised for the following purposes:—

1. For obtaining the opinion of eminent counsel upon the various provisions of the Vivisection Act, so that experimentalists may know when they are really safe and when they are in danger—which at present seems a very open question.
2. For instructing the public and the lay press on the real merits of the question by the circulation of tracts or by advertisements, &c., refuting the sophisms and exposing the inflammatory appeals of our opponents.
3. For petitioning the Legislature against any further restrictions upon physiological experimentation, and for rendering the granting of certificates a matter less dependent upon the caprice of the Home Secretary for the time being than it now appears to be.
4. For defending any person prosecuted under the Vivisection Act.
5. For counteracting and frustrating the system of espionage carried on by the Anti-Vivisection Societies.
6. For obtaining from all the Medical Faculties and Learned Societies of the United Kingdom, a formal Protest against the hysterical and inconsistent agitation now carried on.

There are many other duties which the proposed Defence League might undertake with advantage, and with a fair prospect of success, but to which it would be premature to call public attention. Surely in a matter of such importance all differences and distinctions should be waived, and biologists of all grades and views, medical or non-medical, evolutionists or advocates of distinct creation, animists or materialists, friends of official Science or of independent Science, ought to act together in unity. It must not be supposed that even the total abolition of experiments upon living animals will satisfy our opponents. They will next aim at the prohibition of killing animals for scientific purposes. The possession of serpents and other animals which require to be fed with living prey has been already objected to.

We need scarcely say that, whatever the "Journal of Science" can do towards carrying out the plan above suggested will not be wanting.

VI. THE PTOMAINES AND THE SNAKE POISONS.

IT will doubtless be known to many of our readers that, as far back as 1872, the late Prof. Selmi, of Bologna, succeeded in obtaining from the putrescent bodies of man and other animals a very interesting class of substances, to which he gave the somewhat awkward name of *Ptomaines*. These ptomaines were found to be not ferments, organised beings capable of multiplication, but well-defined crystalline compounds, bearing a very close analogy to the organic bases or alkaloids existing in the vegetable world. Some of them were fixed and some volatile, but each and all, if introduced into the animal system, were capable of occasioning the most alarming symptoms, such as dilatation of the pupils, followed afterwards by contraction, irregular action of the heart, stupor, tetanus, and finally death with the heart in systole. These affections, it was remarked, were very similar to those prodnced by muscarine—the active principle of the more poisonous Fungi.

The first sensation occasioned among chemists and medical practitioners on the announcement of these results was one of alarm, lest in chemico-legal cases a grave mistake had been, or might possibly be some day, committed. Certain of the symptoms produced by these ptomaines, such as the tetanic convulsions and the expansion of the pupils, are what might be expected to be produced by some of the poisonous vegetable alkaloids. The chemical reactions of the two classes of bodies were also found to be respectively similar. There was consequently the danger revealed that if a man was supposed to have been poisoned, his exhumed remains might on analytical examination yield compounds capable of being mistaken for the vegetable poisons, and that thus some person suspected of being concerned in the

death of the person in question might be wrongfully convicted.

Fortunately a method of distinguishing the two classes of poisons has been discovered. The ptomaines have a most intense reducing power. If a small trace of one of them is brought in contact with a trace of potassium ferricyanide—commonly called the *red* prussiate of potash—the latter is instantly converted into potassium ferrocyanide, the *yellow* prussiate. This change is at once known by the fact that the mixture after the reduction gives an immediate blue colour with a small quantity of a ferric salt (persalt of iron), the liquid being of course neutral or very slightly acid.

Certain of the vegetable alkaloids—such as hyoscyamine, emetine, igasurine, veratrine, colchicine, nicotine, and apomorphine—reduce, indeed, the ferricyanide, but less rapidly than the ptomaines. So far, then, we are freed from the terrible risk of being led by deceptive reactions to condemn an innocent person. At the same time it must be admitted that certain highly poisonous artificial bases—phenylic, pyrridic, hydro-pyrridic, allylic, &c.—behave with potassium ferricyanide, and with a subsequent addition of a persalt of iron, exactly like the ptomaines. Certain authorities, indeed, console themselves and the public with the reflection that these artificial bases have not yet found a place among the stock-in-trade of the criminal classes. We fear this is but a broken reed to lean upon, and it is therefore highly important that the properties of the ptomaines should be more thoroughly examined, so as to find some absolute method of detection.

It appears in the meantime that Dr. Gautier was engaged in the investigation of these carcase-poisons almost simultaneously with Selmi, and he has since greatly extended our knowledge of the subject. He finds that the ptomaines are formed not indifferently from any and every portion of the dead body, but solely from its albumenoid portions. What is much more important, he has proved that these poisons are not essentially and solely generated after death and during putrefaction, but occur in the normal excretions of man and of other animals, and in small quantities in most of our tissues. They are, in his opinion, necessary products of the process of dis-assimilation which is constantly going on in the tissues,—a residue, so to speak, of their life. The signification of this idea, theoretical and practical, can scarcely be over-rated.

In urine—not in any diseased condition, but in its normal state—two highly poisonous bodies have been not merely

detected, but isolated. One of these, first obtained and described by Dr. G. Pouchet in 1880, is highly oxidisable, possessing great reducing powers, forming well-crystallised double salts with the chlorides of gold and platinum, and if administered to animals killing them with tetanic symptoms. Along with this compound is found another body, nitrogenous, but not crystalline, not basic in its characters, and, like the former, highly poisonous. These discoveries throw a strong light upon the danger of a retention of the excretions in the body. The poisonous principles resulting from the waste of tissue require to be eliminated as rapidly as possible. If such removal is delayed or obstructed their accumulation must produce the most serious results, as we see in cases where, *e.g.*, the secretion of urine is suppressed. It has sometimes been noticed that the flesh of animals which have died immediately after unusual exertion, or after prolonged torture, is unwholesome, or even poisonous. This has been observed in the case of over-driven cattle, and of a baited bull. The most signal instance—the exact particulars of which we are unable to remember—is that of a roebuck which had been caught in a snare, and which had evidently died after very prolonged efforts to escape. All the persons who partook of its flesh became seriously ill, and, as far as we recollect, two of them died in consequence. In view of the researches of Dr. Gautier and Prof. Selmi these facts become perfectly intelligible. Prolonged and unusual exertion involves an abnormally great waste of time, and consequently an excessive production of ptomaines. If, then, the animal is killed and eaten before the elimination of the poisonous matter can have been effected, the persons who consume it are, as a matter of course, injuriously affected to a greater or less degree. The possible existence of these poisons in animal tissues may very probably be employed by the "dietetic reformers" as an argument in favour of vegetarianism. It must be remembered, however, that if we are to eat no substances which may contain traces of poisons, we shall probably have to extend our reforms so far as to dispense with food altogether.

But though the existence of the ptomaines furnishes no valid reason for the disuse, in food, of the muscular flesh of animals killed rapidly, when in a normal condition, the case is very different as regards the blood and the glands. Here, according to Dr. Gautier, we may find them in relatively larger quantities.

Dr. Gautier has sought for poisons of the ptomaine class in that part of the vegetable kingdom which makes the

nearest approach, chemically and physiologically, to animals, —*i.e.*, in cryptogamous plants. He finds that *muscarine*— the poisonous principle of certain Fungi—closely resembles the ptomaines both in its chemical behaviour and in its physiological action. It rapidly reduces the ferricyanide, and it kills with the heart in systole.

We next encounter another phase of the subject. The poison of serpents has been for thousands of years a mystery, both as regards its nature and its possible treatment. At last, thanks to the researches of Dr. Gautier, we are beginning to see light. He has obtained a small quantity of the venom of the lance-headed snake of Martinique (*Trigonocephalus*) and of the cobra (*Naja tripudians*). In each of these he has found an alkaloid, yielding crystalline hydrochlorates, chloroplatinates, and chloraurates, giving precipitates with the usual reagents for the vegetable alkaloids, rapidly reducing potassium ferricyanide, and, in short, possessing all the properties of the ptomaines. In the venom of the cobra there was also another compound of non-basic character, but exceedingly poisonous. We naturally ask whether this second substance is identical with that isolated by Dr. Winter Blyth, and named by him cobric acid? Dr. Blyth and Dr. Gautier certainly agree that the poison of the cobra is not a "figured ferment" or a virus, but a true chemical compound. As evidence for this view it appears that the venom may be boiled in aqueous solution, filtered, evaporated in the water-bath after acidulation, and filtered again without losing its activity, Further, the venom— which had been dry—was moistened with water, and heated for several hours to 120° to 125° C. (248° to 257° F.), yet its deadly power was scarcely affected. Moreover, its effects were diminished by a reduction of the dose and by dilution, just as would be the case with arsenic or prussic acid, and as is not the case with the ferments.

On the other hand, Dr. de Lacerda, who has been carrying out a long series of experiments with the Brazilian serpent *Bothrops jacaranda*, comes to very different conclusions. He states the poison lost its efficacy if heated to 90° C. (194° F.) or cooled down to the freezing-point. He also observed, under the microscope, minute briskly moving bodies, which were paralysed by an admixture of alcohol, chloroform, or boracic acid. Here is a perplexing discrepancy. We can well understand the presence in serpents belonging to different groups, of different poisons or of different ferments. But it is little likely that there should occur in one a true poison, and in the other a morbific ferment. Among the

substances which Dr. Gautier has tried without success are tannin, ferric chloride, nitrate of silver, a variety of essential oils, aldehyds, alcohols, phenols, and ethers, Ammonia delayed death a little, without otherwise affecting the result. A small quantity of dilute caustic potassa or soda was found successful.

This result is the more interesting as it is completely in harmony with that obtained by Dr. de Lacerda, in his experiments on the venom of *Bothrops jacaranda*. He injected into a vein of the animal from 2 to 3 c.c. of a solution of potassium permanganate, containing 1 per cent of the solid salt. Every chemist will see that the permanganate would be rapidly decomposed, and that caustic potassa would be formed. This injection was made upon animals which had received a dose of the poison, and which were already manifesting its characteristic symptoms, such as a great dilatation of the pupils, irregular action of the heart, &c. Yet in a few minutes after the injection of the remedy these symptoms disappeared, and there remained merely a general prostration, which did not last longer than a quarter of an hour. In blank experiments made upon other dogs, the poison being injected without being followed by the antidote, death invariably followed. Both Dr. de Lacerda and Dr. Gautier operated in such a manner as to exclude all sources of uncertainty. If we cause an animal to be bitten by a serpent question may arise as to whether the poison-gland might not for the time being have been exhausted, and, if not, whether the poison has been really introduced into the tissues of the subject. But both these experimentalists collected the venom of the snakes, and injected it into the subjects in exactly known quantities, so that no doubt can exist.

A very curious result is that the poison becomes much more active if previously digested with gastric juice at temperatures at from 20° to 39° C. (68° to 102° F.). On the other hand, the bile seems in all probability to have the power of destroying, or at least of delaying, the efficacy of snake-poisons. Popular tradition, in many countries, asserts that the gall of every poisonous animal is a remedy against its bite. We may now remove this belief from the region of superstitions to that of established facts, with this only reservation, that the gall of one animal is not more especially efficacious than that of another.

Dr. Gautier, after having thus established that the ptomaines, or substances closely analogous, are normal products of all animals, and after tracing them in the venom of

serpents, was not unnaturally led to seek for similar products in human saliva. It has long been known that a severe bite inflicted by a man or woman, especially in a state of rage or other excitement, has proved fatal. The salivary-glands in man are the representatives of the poison-glands of serpents. Prof. Oken used to declare that the saliva had the "signification of poison," and that one of its functions was to destroy the molecular life of the substances eaten. In human saliva a poison not inferior in activity to that of the more formidable alkaloids seems actually to exist.

Dr. Gautier obtained 20 grms. (nearly $\frac{3}{4}$ ounce) of normal saliva, and evaporated it down in the water-bath. There remained a residue weighing $\frac{1}{4}$ of a gramme, or nearly 4 grains. After being exposed to the temperature of 212° F. for three hours, this residue was re-dissolved in tepid water. If the liquid thus obtained was injected under the skin of birds the result was generally fatal, the symptoms being dilatation of the pupils and complete stupor. He has not yet isolated the poisonous principle of the saliva, but he finds that the watery extract prepared as just described immediately reduces the red prussiate of potash. Further, on treating the extract of saliva with a little dilute hydrochloric acid, and then with Meyer's reagent, a precipitate is obtained which, when washed and decomposed with sulphuretted hydrogen, gives a solution from which a hydrochlcrate is deposited in fine microscopic needles. The solution of these minute crystals forms, with the chlorides of gold and platinum, crystalline but very unstable salts.

Hence we see that the venom of serpents is no exceptional anomalous product, but merely an intensified modification of ordinary saliva. We may now understand how it comes that animals, in very different parts of the zoological scale, up to the ruder portion of our own species inclusive, spit at an enemy. It might be important to subject the saliva of such animals—*e.g.*, the llama—to a special examination. Snakes are known occasionally to project their venom, and it is quite possible that such a spirt falling upon the eye, the lips, or the nostrils, might occasion serious results. We sometimes hear reports of illness, or even death, produced by the bite of some animal not officially recognised as venomous, and certainly not provided with hollow fangs. Such accounts are generally rejected as fabulous. But, making all due allowance for exaggeration and distortion, it is still probable that the saliva may, under certain conditions, be more highly charged with poisonous matter than is usual. Here careful observation is needed.

A further question may here arise : the saliva in all animals is constantly being secreted to a greater or less extent, and as constantly being swallowed. Why does it not occasion injury to the organism ? It is no answer to this question to refer to the very similar case of the cobra, which in like manner swallows the overflow of its own poison-gland. The cause may probably be that the poison is destroyed in the intestinal canal by coming in contact with the bile.

From poisonous saliva as a general case we are naturally led to its especial form in rabies. On this subject Dr. Gautier has not experimented. The symptoms of hydrophobia, however, differ very strikingly from those produced by the ptomaines, by mushroom-poisons, snake-poisons, &c. One very characteristic difference is the time of incubation which the matter of rabies requires, after its introduction into the system, before the morbid symptoms are manifested, whilst the evil effects of the poisons above mentioned are rapid, if not instantaneous.

The poisons of insects, &c., ejected by a sting at the tail, do not for the most part seem likely to belong to the ptomaines. In the bees and the ants the venomous secretion is strongly acid, and has been proved to contain the formic acid. Whether its effects are in part due to any other principle is still an open question. In wasps, however, the venom, as was first demonstrated by Prof. Church, and as we have fully verified, is decidedly alkaline, and may possibly contain some compound of the ptomaine class.

As far back as the year 1872 Dr. Corre remarked that cases of poisoning from the consumption of poisonous fishes resemble entirely, physiologically speaking, those produced by the bites of serpents. Hence there is a strong probability that the tissues of such fishes contain substances chemically identical with the active principle of the venom of serpents and with the cadaveric poisons. To what end these poisons serve in most cases, or on what account they have been developed, is still utterly unexplained. We can see a reason why a cobra or a rattlesnake should possess a poison sufficiently powerful to kill its prey, and that rapidly. But it does not appear what the serpent gains by a poison so much in excess of what is neeeed for this purpose. The snake is not protected against the larger animals by this weapon, since if a man, a large dog, a tiger, &c., has been bitten, he has still ample time to take vengeance on the assailant. It seems, therefore, that serpent-poisons can scarcely have reached their present intensity by the action of Natural Selection.

VII. SEXUAL DISTINCTIONS AND RESEMBLANCES.

By Frank Fernseed.

In the "Journal of Science" for 1878 (p. 469) there appeared an article on the "Woman's Rights Question," considered from a biological point of view. In that article the writer showed that the assignment of different duties and employments to men and to women respectively, which certain political and social agitators think proper to call the "subjection" or "subjugation" of the latter, so far from being peculiar to the human species extends throughout the great mammalian class, and when calmly considered, is merely an instance of that differentiation which is a characteristic of all progressive development. More recent researches have extended and completed his argument, carrying it out even into numerical details. It may, therefore, not be uninteresting to present a notice of the points of difference between the sexes—morphological and physiological—as summarised by M. G. Delaunay in the "Revue Scientifique."

We must first mark that in most of the lower sections of the animal kingdom the female is the larger, the stronger, and the better armed. As instances may be taken, many molluscs, especially the Cephalopods, many Cirripedia, most of the Annelida, and probably the majority of insects. Most distinctly is this the case among moths and butterflies, and no less among the Hymenoptera. Indeed, among the highest forms of this latter order, the bees, wasps, and ants, the male is unarmed—comparatively feeble; and as far as we can judge from the structure of the brain, not endowed with the same intellectual power as are the females and the neuters, which are now well known to be merely modified females.

In some of the Coleoptera, especially the Lamellicornes. the male is the larger and stronger, but this is far from universal. Among spiders the superiority of the female is most signal, the males in some cases being so diminutive that they have been, till lately, placed by systematists in different species and even genera. Even among vertebrates the female is still the larger in many fishes and reptiles. It

is not till we came to the warm-blooded animals that these relations are reversed. Among birds, save in a few predatory groups, now no longer placed at the head of the class, the male is the larger. This is most strikingly the case in the so-called Rasores or Gallinaceous birds, of which the common domestic fowl is the type. The case is very similar among aquatic birds. Thus the male swan, or "cob" as he is called, is much larger and heavier than the female, or "pen."

In the highest vertebrate class—if M. Minot will allow me still so to call it—that is, the Mammalia, the superiority of the male in bulk, weight, and strength is without exception. Nor is this difference in size the only distinction. In the male the phenomena of nutrition is more intensified. The blood is on the average denser and redder, containing more red corpuscules and hæmoglobine, and on the other hand fewer white corpuscules and less water. Malassey has even proved that man has in a cubic millimetre of blood a million more red corpuscules than has woman. Size for size, male animals eat more than do the females of the same species. I have known not a few men who have been quite uneasy concerning the small appetites of their wives or daughters, fearing it a sign of illness. It is proved from the experience of public charities that it costs more to feed a boy than a girl. Yet though women eat less, or, perhaps, for that reason they are inclined to eat more frequently. Of this the "five o'clock tea," intercalated between lunch and dinner, is an unwholesome instance.

With the work of the respiratory organs there is a corresponding difference. If we take a man and a woman of equal stature the capacity of the lungs in the man will exceed that of the woman by half a litre, or about 7-8ths of a pint. In the human species, according to Quetelet, between the ages of fifteen and fifty the female takes one inspiration more per minute than does the male, who, however, absorbs more oxygen than the female, and at all ages excretes more carbonic acid. Hence a hundred men will deteriorate the air of, *e. g.*, a lecture-hall or work-room, more quickly than will an equal number of women, and will consequently require a larger supply of fresh air. The temperature of the body is also measurably higher in the male sex.

If we examine the circulatory system, we find the pulse less frequent in man than in woman, but the pressure of the blood is stronger. The sexual difference of the number of pulsations in several species has been determined as follows:

—In the lion 18 beats per minute; in domestic cattle 10; in sheep 12; and in the human species, a number which varies from 10 to 14. Thus in the functions of animal life the male is distinctly pre-eminent.

The structural differences between the two sexes are by no means confined to mere height, breadth of shoulders, or depth of chest. The skeleton of the male is not only positively but relatively heavier than that of the female, bearing a larger proportion to the total weight of the body. The bones of a man contain a larger percentage of mineral matter and a smaller proportion of organic matter than those of a woman. Not only so, but there is a difference in the components of the inorganic portion, the male skeleton containing relatively more carbonate of lime and less phosphate of lime than that of the female. Livon asserts that the left shoulder-blade is larger than the right in women,—a difference which in the inferior races of mankind extends to both sexes. According to Broca the length of the clavicle in comparison with the humerus is greater in women than in men, just as it is greater in the negro than in the Aryan race. It is also said, though I doubt if the evidence is conclusive, that women use the left arm, and altogether the left side, more than do men. They are certainly more given to centripetal as contrasted with centrifugal movements than are men. Thus a woman, if cutting any article, brings the knife towards herself, whilst a man under similar circumstances cuts outwards, or away from himself, and is thus much less liable to hurt his hands.

In the voice there is also, in many of the higher animals, a sexual difference analogous to that which exists in our own species, the voice of the male being the deeper and more powerful.

In amount of muscular energy there is also a wide difference. The strength of an average woman in civilised countries is only about two-thirds of that of the average man. In the larger apes the difference is much greater.

I turn next to the skull, with its appendages and its contents. It is found that in the Aryan race women are relatively more prognathous than men, approximating in this respect to the condition of the lower races. The skull is decidedly more bulky in the male sex throughout all mammalian species which have been examined. Wiesbach determined its cubic contents in German women, and in men of the same nation, to bear the respective proportions of 878 to 1000. Morselli finds the difference somewhat greater, or as 850 to 1000. Broca states the excess of size in men, as

compared with women, to be 150 c.c. for the French generally, but as much as 211 c.c. for the inhabitants of Paris. There is also a difference in the shape of the skull, which is relatively longer and less elevated in women than in men.

The brain of men is heavier than that of women, not merely absolutely, but in proportion to the weight of the entire body. Thus the average size of woman bears to man the proportion of 927 to 1000, whilst the weights of the brain are respectively as 909 : 1000. Even when of equal size the brain in the female is lighter than in the male. The mean weight of seventeen male brains exceeded that of seventeen female brains, of the same size, by nearly 6 ozs. We find also relative differences of structure.

Broca, Wagner, and Huschke agree that in women the frontal lobes are less fully developed than in men, the difference in favour of men being, according to the last-named observer, as much as 54 c.c. In return the occipital lobes are bulkier in the female sex. It is considered by some authorities that the right brain is more developed in women, and the left in men,—a difference which, if established, would explain why in passing men generally keep to the right hand and women to the left.

From these data are drawn the following conclusions :—

"The superiority of the female sex is witnessed only in the inferior races of mankind and in the young children of the higher, and marks an inferior stage of evolution.

"The same is the case with the equality of the sexes, which occurs merely in imperfectly developed varieties and species, in young persons, in the decline of years, and in the lower classes of society.

"On the other hand, the pre-eminence of the male as compared with the female marks a higher stage of evolution. It occurs in the highest species and races, in the prime of life, and in the superior strata of society.

"Both morally and physically Evolution appears to have traversed from a state of superiority of the female to a state of superiority of the male, equality of the sexes representing a transition or intermediate stage."

These results, I fear, will not be welcome to the successors of John Stuart Mill. But when did a "reformer" stoop to consider such trifles as biological facts ?

ANALYSES OF BOOKS.

The Human Species. By A. DE QUATREFAGES. Second Edition. London: C. Kegan Paul and Co.

WE must admit having deferred to a somewhat late point of time our survey of this important work, of which the excellent English version before us is now in the second edition. The primary idea of the author is to prove that all the beings commonly known as men belong to one and the same species, which was originally localised in a relatively very limited space, from which it has spread out over the whole globe by means of successive migrations. But the work has other and subsidiary objects, which, without any departure from the courtesy of criticism, we may characterise as belonging to the official school of French biology rather than to that which has established itself in the rest of Europe and in America. M. de Quatrefages is a disciple of Cuvier; he upholds the real existence of species, and consequently their permanence; he attacks the doctrine of Evolution; he denies the existence of permanently fruitful hybrids; he maintains a distinction between man and the lower animals, not merely of degree, but of kind. Thus in many of the most important points of theoretical biology he belongs to the first quarter of the present century. He admits, however, that man has existed upon the earth longer than is laid down by current traditions.

In the introductory chapter M. Quatrefages declares himself a vitalist. He does not accept the view—now becoming increasingly current—that the peculiar phenomena of living beings can be accounted for by mere physical and chemical considerations. His idea of life is "no more the *archeus* of Van Helmont than the *vital principle* of Barthez," but a name given to the "*unknown cause* which produces filiation, birth, and death." Here we are with him in so far forth that, pending actual proof of the production of organic phenomena by what are called inorganic agencies, we must pronounce it perfectly legitimate to speak of life as a distinct force. But we must here recognise a distinct breach in the principle of continuity. Until it has been distinctly demonstrated that the phenomena of the animal and vegetal worlds can in their entirety be explained by physical or chemical laws, we must admit that Nature has here done something *per saltum*. The author's views on this subject may be summed up in the statement that he ascribes the phenomena of the vegetable world to the "action of three forces—gravitation,

etherodynamy, and life." To the animal world he attributes, in addition, a fourth force—"the animal mind." Here, therefore, we have again another breach of continuity. The animal and the vegetable kingdoms are, according to M. de Quatrefages, not two stems from one common root, diverging more and widely from each other as they rise higher and higher, but two radically distinct totalities. It must even follow, on this view, that the lowest animal is superior to the highest plant.

But we come now to a more important violation of the principle of continuity. The author asks "Whether man should take his place in the animal kingdom? a question which evidently leads to another: Is man distinguished from animals by important and characteristic phenomena, absolutely unknown in the latter?" He continues, "For more than forty years I have answered this question in the affirmative, and my convictions, tested by many controversies, are now stronger than ever." Our reply is, "For more than forty years we have answered this question in the negative,—even on the hypothesis of distinct creation,—and our convictions, tested by the examination of all arguments raised on either side, are now stronger than ever."

One of our chief grounds for rejecting the doctrine of a great gulf between man and his "poor relations" is that scarcely two of its numerous champions advance the same reasons for their faith, and that each industriously and learnedly refutes the arguments of his fellows. We simply pay them the compliment of accepting their critcisims whilst rejecting their dogmatic teaching.

What is the evidence which our author advances in support of his assumption? We cannot expect that the learned academician would fall into the gross error of seeking to establish his theory by anatomical and physiological considerations. He says "It is neither in the material disposition nor in the action of his physical organism that we must look for these phenomena. From this point of view man is neither more nor less than an animal." Yet he makes afterwards certain remarks which can scarcely be brought into harmony with the great truth thus announced. For instance (p. 107) he tells us that "in man the organs are so arranged that he is essentially a *walker*, while in apes they necessitate his being a *climber* just as strongly." But what weight can be assigned to such a characteristic? In climbing and walking powers the apes vary greatly, and the gorilla, though he can climb, is much less arboreal and more terrestrial than the mias. Man, where circumstances permit it, is even yet an instinctive climber.

M. de Quatrefages further declares "Man also is evidently an exceptional or aberrant type among mammals. He alone is constructed for a vertical position; he alone has true hands and feet." The difference between the human and the simian type of hands and feet is so palpably one of mere degree that no ex-

ceptional position can be assigned to man on that account. The mere existence of the very decided heel-bone in the gorilla is quite sufficient to overthrow the foundation of the Cuvierian "Quadrumana." As for the vertical position of man, it is evidently simply the extreme form of a graduated series. All the apes when sitting have their vertebral column in an almost perpendicular position, and a gorilla when walking through bushes is very nearly erect.

To return to our author's survey of the distinctions between man and the rest of the animals, he admits that no line of demarcation can be found in the regions of the passion and emotions. He concedes also that man has true instincts. Nor does he find the boundary in intelligence, rightly pointing out that it is "not the *intensity* of a phenomenon which gives value to it from our present point of view, but simply its *nature*." He quotes the admission of the Pere de Bonniot, that animals possess a principle superior to mere matter, and to which we may give the name of mind; and that of M. l'Abbé Lecomte, that animals reason and judge. He claims for them innate sense and consciousness, and if he does not also add "reason" it is because of a circumstance to which he refers below. He rejects also Prof. Max Müller's alleged "Rubicon" between man and beast, showing that here also we have gradation, but not contrast. He goes on :—"In man the existence has been proved of fundamental phenomena, of which nothing, either in living beings or inanimate bodies, has hitherto been able to give us any conception. 1st. Man has the *perception of moral good and evil* independently of all physical welfare or suffering. 2nd. Man *believes in superior beings* who can exercise an influence upon his destiny. 3rd. Man *believes in the prolongation of his existence after this life.*"

We must entirely traverse these alleged demarcations. We maintain that—

1st. The points advanced—two of them beliefs—are insufficient to warrant the inference sought to be drawn. Suppose it could be shown that all dogs or all chimpanzees entertained some belief—whether well- or ill-founded it matters not—which was not shared by the rest of the animal world; it would surely not warrant us in regarding them as fundamentally distinct.

2nd. It is not demonstrated, but merely assumed, that the lower animals have no perception of moral good and evil, and have no belief in the existence of superior beings or of a future state. On the other hand, there are phenomena which lead us to believe that they have rudimentary perceptions of right and wrong, and even suspicions of the existence of an order of Nature, any departure from which inspires them with a vague dread. But even in the absence of any distinct evidence to such effect, to follow M. de Quatrefages would be to found a classification upon our own ignorance!

3rd. Many men believe that our perceptions of moral good and evil have been gradually developed on utilitarian principles. Nor can we shut our eyes to the fact that multitudes of intelligent men consider the belief in superior beings and in an after-life a mere delusion.

But whilst thus rejecting the author's distinctions between man and the lower animals as utterly worthless, we must further express our opinion that the subject is here wholly beside the question. The unity or diversity of mankind is unaffected by such considerations as whether man forms a distinct kingdom, a distinct class, or merely a separate family or perhaps genus. What may have been the motive of M. de Quatrefages in beginning his task in the manner he has selected we have no right to pronounce.

In several of the following chapters the author is concerned with the reality and permanence of species, and with anti-Darwinism, or rather with anti-Evolutionist polemics. He here brings forward little, if anything, which has not been repeatedly advanced elsewhere, and has been found wanting. His characteristic defects here are a disposition to overlook or undervalue the palæontological and embryological evidence, and to cling to the notion of "filiation." In other words the author, if we do not misunderstand him, contends that because in the few centuries over which our observations extend, and in the few cases which have been studied with sufficient closeness and accuracy, we have seen plants and animals vary merely within certain limits, therefore species are permanent. This is the "Egyptian" argument, first raised by the members of the French scientific expedition to Egypt under the first Napoleon. It has been well remarked that this argument proves too much!

We cannot help here recording our protest against the spirit of many passages of the present work. He forgets that prejudices may be more easily Cuvierian than Darwinian. He speaks of men carried away by their enthusiasm, throwing overboard the results of their illustrious predecessors. Is he not aware that Darwin has been and still is one of the most patient and persevering observers and experimentators the world has ever witnessed? Are not his disciples, of whatsoever nationality, zealously following his example? Does not the balance of facts observed point so uniformly *against* the fixity and reality of species that the day for useful discussion is well-nigh over? In short, as an eminent German naturalist has well said, we no longer enquire whether transformation has taken place, but how it has been effected.

Anent the distribution of the human species M. de Quatrefages speaks of the centres of creation, or rather of appearance, "a doctrine entirely French in origin, having been formulated by Desmoulins and developed by M. Edwards." He might have added, "and entirely out of harmony with facts as now ascertained."

The researches of modern zoo-geographers supply no evidence of a number of independent centres of origin of animal forms. The facts speak in favour of successive waves of species spreading out from the northern hemisphere, and distributing themselves over the rest of the world according as channels of communication were closed or opened. If this section of the work has been recently revised by the author the circumstance is profoundly to be regretted. The author, criticising Agassiz, says :—" Agassiz includes New Guinea in the Australian kingdom. He thus destroys the homogeneity of the mammalogical fauna." This is a strange assertion if we consider that a species of that characteristically Australian genus *Echidna* has recently been discovered in New Guinea.

A prominent feature of the work is the position taken by the author on hybridism. Modern research tends to show that hybrids frequently originate in a state of Nature, and that they are not necessarily devoid of the power of reproduction. The hybrids produced between the domestic cattle and the American bison, which belong not merely to different species, but to different genera, are a remarkable case in point. It seems to us that the author assumes that two species in one genus must be as remote from each other morphologically and physiologically as two species in some other genus. Deny this totally unproven proposition, and the negative instance of the mule—upon which so much weight is laid by the naturalists of the old school—loses all its general value,

We find, on p. 143, an attempt to justify, or at least to palliate, the conduct of Cuvier as regards the discovery of fossil human remains in the year 1823. Says our author " The reproach is unjust. Cuvier had too often seen pretended fossil men change either into mastodons or salamanders not to be on his guard." Caution in forming judgment on a novel or possibly unique fact is doubtless highly commendable ; but when that caution takes the form of refusal or neglect to give the disputed specimens a full and fair examination, it deserves, and generally obtains, a much harsher name.

Having disposed to his own satisfaction, and doubtless to that of official scientists in France, of these accessory questions, M. de Quatrefages proceeds to his main subject—the Unity of the Human Race. It may perhaps be maintained that the work would have had a higher permanent value had it opened with the Fifth Book. He shows in succession the possibility of man, even in a savage state, gradually overspreading the whole earth and becoming gradually acclimatised. He then treats of primitive man, of the formation of human races under the influence of the conditions of existence and of heredity, the origin of mixed races and the effects of crossing. He describes the fossil races, such as those of Canstadt, Cromagnon, and Furfooz. He next turns to the physical characters of mankind, anatomical,

physiological, and pathological, seeking in all these departments essential unity. In bringing into prominence the fact that all human races are subject to almost every disease, he might fittingly have extended his observations to the apes, who undoubtedly share many of our maladies, and under certain circumstances would doubtless be susceptible to them all. It is known that in the most unhealthy part of the season monkeys migrate away from the Teraï. In the last Book he traces the elements of unity in the intellectual, moral, and religious features of the entire human race.

The main, essential portion of the work is very much less open to criticism than the preliminary sections, and even those who do not admit that the human race might have sprung from a single initial pair may read it with pleasure and profit.

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*Das Princip des Westganzen und der Polarismus.** Von D. E. Mielke. Berlin: Theobald Grieben.

We have here, in brief compass, a far-reaching work. The author criticises the received scientific system, and proposes a substitute in its place, which he works out in astronomy, in the doctrines of atoms and cells, in botany and zoology, and in human thought, consciousness, and will. His fundamental principle is polarity. He considers that the mechanism of the heavenly bodies as commonly taught, as well as the hypothesis on the origin of the planetary system, due to Kant and Pezholdt (*i. e.*, the nebular hypothesis), appear unsatisfactory and "one-legged." The dualistic motor provided for the planets, consisting of the centrifugal and centripetal force, excites alarm lest the heavenly bodies, in consequence of total loss of heat, should perish from excessive condensation and from the shortening of orbits. The author considers it as unsatisfactory that the planets should be masses agglomerated out of chaos without internal organisation and polar activity. He considers that the problem of philosophy is to find the true mean between the subjective idealism hitherto cultivated and a materialism degenerated into the unnatural.

Turning by predilection to the chapter in which the author applies his principle to the organic, and especially to the animal world, we find him remark that plants and animals have this in common, that at one end the root or the head is organised for the reception of nourisment. At the opposite extremity the reproductive organs. But how about the many cases where the intersusception of food and the production of seed or ova are not placed at opposite extremities? We need only refer to the

* The Principle of the Universe and Polarism.

common snails and slugs, where the generative organs are placed in the neck, and to the earth-worm, where they form the so-called saddle about the middle of the body.

The author calls attention to the Lichtenbergian figures of positive and negative electricity in comparison with the human nervous and cerebral system. He places, again, the brain with the organs of sensation as one pole of a system, whilst the generative organs form the opposite. As a second system he adduces the heart and circulatory system with the respiratory system and the vocal organ. The third main system of "two-ended and two-sided" activity is the muscular tissue. The author considers that plants bear the same relation to the earth's surface that hairs do to the animal. The vegetable world dates back to a remote past. Among physiologists it is possible to agree with those only who accept equivocal generation as a cosmogonic appendage.

Having thus given a short sketch of some of the author's leading doctrines, we must pronounce the work as indeed suggestive, but somewhat deficient in clearness.

On the Teaching of Science in Public Elementary Schools. By W. J. Harrison, F.G.S., Science Demonstrator for the Birmingham School Board. Birmingham: Herald Printing Office.

We find in this pamphlet very much which commands our most hearty approval. The attempt to give even primary education a more re-al—we divide the word to remind the reader of its etymological meaning—instead of its present exclusively verbal character is deserving of every encouragement. It is generally supposed that the main motive which induced the Government of this country to undertake seriously the task of national education was the spectacle of other countries gaining ground on us, and seriously challenging our commercial and manufacturing pre-eminence. But both Government and nation forgot that no amount of the three R's can, from the very nature of things, meet the exigencies of the case. The youth of this country should, we submit, be trained in the art of observation, so that they may learn a lesson from every object and every fact which they come across. This training has been till lately at least conspicuous by its absence in every grade of English education from the village school to the university, and the many illustrious discoverers and inventors to whom this country owes so much of its greatness have risen not by the aid of what they had learnt, but independently. Hence it is that we attach so great value to the attempts of which this pamphlet speaks. The writer is fully

justified in pronouncing the scheme of teaching—*e.g.*, Natural History—in the guise of reading-lessons a grave error. True, the leading facts of Natural History may thus be somewhat dimly implanted in the minds of children, but they will never on this system be taught to observe and to draw correct inferences from the phenomena around them. To learn any branch of the natural sciences rightly we must go to things, and make use of books merely for recapitulating and systematising our knowledge.

The plan adopted in Birmingham of having a Science Demonstrator who attends the schools to give lessons in rotation, and has the materials requisite for illustrative experiments taken round with him, is an admirable plan for combining economy with efficiency. We are happy to learn that the children show a lively interest in the lessons.

Osteology of Lanius Ludovicianus var. *Excubitorides*. By Dr. R. W. Shufeldt.

We have here an osteological monograph of the variety *Excubitorides* of the shrike, *Lanius Ludovicianus*. The characters of this bird, as a type of its group, are beautifully displayed in the accompanying plate of its skeleton. Here, as the author remarks, we see the general framework of an ordinary insessorial bird, which might belong, *e.g.*, to a thrush, yet surmounted by a raptorial skull, approaching that of a hawk. We seem to see here a transition not yet completed. Dr. Shufeldt does not indicate any other raptorial feature save the "decided curvature of the bird claw," but we may possibly lay too much weight upon this characteristic from our knowledge of the habits of the bird. It is singular how few birds are either purely vegetarian or purely carnivorous. It has been remarked that some of the most decided fruit-eaters turn predatory in severe seasons, and even attack their own kind. The idea of a strictly defined "natural food" for any animal species is fading away like that of species themselves.

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

A NEW SEISMOGRAPH.

To the Editor of the Journal of Science.

Sir,—I notice an article in "Nature" for November 3, 1881, headed "Lunar Disturbance of Gravity." Of course it is possible, as I know to my cost, for a new theory to originate with the printer's boy; but the gist of this paper is evidently the description of a delicate seismograph, which reflects great credit on its constructors. Indeed it is notable there is no effort put forth to establish the theory of a disturbance in *a*—or *the* if it be—land-tide as eliminated from extraneous circumstance during the course of the paper, the matter being left among the desirables stated at its commencement. One fact, however, is duly arrived at, and circumstantially stated towards the close; namely, that the effect of frost and a wet season combined is strongly marked, for on January 23rd, 1881, a foundation-stone was 4·12 m.m. higher than it was on September 7th, 1880; and also that the prolonged drought of the present summer (this must refer to England, for it has been a proverbially wet year in Scotland) has had a great effect, for between May 8th and June 29th the stone sank through 5·79 m.m. This matter then, I suppose, is quite undeniably Solar Physics proper, and it should tend to place, without the bourns of mere theoretical assumption, the notion that superficial earth tremours may be so produced. Indeed the writer of the paper would lead one on yet farther, for he adds:—The changes produced in the height of the stone are, of course, entirely due to superficial causes; but the amounts of the oscillations are certainly surprising, and although the basements of astronomical instruments may be very deep, they cannot entirely escape from similar oscillations." This I suppose to refer to the leverage exerted by the expansions and contractions in the crust of variable temperature, which, as Page tells us in his "Text-Book of Geology, should be taken to be 60 or 90 feet in vertical depth. Indeed, as I understand, it has been already mooted to

place this new seismograph at the bottom of a mine; but can any assure us that even then no tremour of the earth shall there penetrate, and that the astronomer shall see nought, hear nought, feel nought, but the gentle influence of Astarte. This will surely prove a knotty point for the mathematician and mechanic.—I am, &c.,

A. H. SWINTON.

Binfield House, Guildford, November 15, 1881.

HYLOZOISM *versus* ANIMISM.

To the Editor of the Journal of Science.

Communicated by DR. LEWINS.

SIR,—I venture to request the insertion of a few observations upon Mr. Barker's article in the October number of this Journal. The motto "God is light" appears to me a suicidal one, since light, on either theory of its nature, is a purely material force. Plato, Socrates, &c., are quoted in support of Animism; but it is well known that the existence of "spirit" as an immaterial entity was as yet undreamt of in ancient philosophy. I do not assert that Matter is "what men in general call Mind," but that mind is a function of matter, and surely the word "function," which signifies office, duty, or operation, is neither vague nor ambiguous. Hylozoism is independent of the Lucretians and of every other atomic theory, while it includes and completes the idealism of Berkeley, as implied in the sentence which Mr. Barker declares "unintelligible." The doctrine of "centres of force," which places mental and vital energy on the same level with heat, light, and electricity, is only another mode of stating the same thesis. As Berkeley affirmed, all phenomena are the product of mind—*i.e.*, of thought and sensation; but these powers must belong to some conscious entity. The grey matter of the cerebral hemispheres (of whose noumenal nature we are of course entirely ignorant) has been proved by modern research to exercise mental functions, and to be, therefore, the proplasm of the mind, or "subjective universe." Farther we cannot penetrate, but are fairly entitled to say—the Brain thinks, *ergo* it exists. The volitions of man are, in the last analysis, as purely due to physical causes as the fall of a stone. As regards my argument, the etymological signification of "vis insita" is totally unimportant. Practically it means immanent, innate, or inalienable. No flippancy was intended by the phrase "ghostly Archeus;" ghostly being the Anglo-Saxon equivalent of "spiritual" and "Archeus," the normal term in pre-scientific Physiology to denote the imaginary and occult active principle of the material

world, and the power "behind" organic function that presides over "the animal economy." The illustration drawn from the old phlogistic theory of combustion remains intact. There was no *analogic* ground for supposing a "levitating factor" which "could have united with a metal without being condensed into a solid." Neither is there any such ground for the belief in an "anima" or "vital principle." Again, when a man is excited by alcohol he manifests a temporary exaltation of vital, and often of mental, power; but nothing analogous to this happens in the case of a broken fiddle. All discussions based on theological dogmas are out of place in a scientific journal; I therefore simply remark that if we assume the existence of an *ubiquitous* Deity—an assumption Hyloism is not concerned to dispute—we must believe that he acts in all cases directly, and not by living or lifeless mediation,—

> "Warms in the sun, refreshes in the breeze,
> Glows in the stars, and blossoms in the trees,"—

and that the material Universe is but the Epiphany of God. Is this a "degrading" theory?—I am, &c.,

C. N.

PROFESSOR HUXLEY ON ANIMISTIC HYPOTHESES.

To the Editor of the Journal of Science.

SIR,—Professor Huxley, in a Lecture delivered before the Medical Congress, asserts that "The essence of modern, as contrasted with ancient physiological science, appears to lie in its antagonism to animistic hypotheses and animistic phraseology."

Prof. Huxley is never ambiguous in his utterances, and it is very difficult to avoid applying an animistic hypothesis to the function he was fulfilling in this portion of his admirable address. I would, however, suggest that the opposition of Science is directed against *inadequate* rather than against *animistic* hypotheses.

For example: the hypothesis that the process in germination is similar in its nature to that in crystallisation is grossly inadequate and misleading, and, as such, is condemned by Science.

It is not Prof. Huxley's custom to complain of that which is inevitable; and it is to be feared that in our modes of thought and expression we cannot help being animistic, any more than

we can help being anthropomorphic. In Biology 'mimicry' cannot be discussed except in terms which belong to animism. The remedy is in the Professor's own hands: let him show that all animistic potency is mechanical, and the offence ceases.—I am, &c.,

HENRY H. HIGGINS.

OCCURRENCE OF EARWIGS.

To the Editor of The Journal of Science.

SIR,—S., at page 690, writes of the *abundance*, "almost *beyond precedent*," of earwigs. As an old grower of roses, carnations, and dahlias, for over twenty-five years, I know an earwig when I see him (which is death to the earwig), but this summer—strange to me, as doubtless it will be to S.—*I have not seen a single one*. I grew a hundred pots of carnations, and more than once remarked on the absolute freedom from the "nibbling thieves." My garden faces North, on a steep hill-side, and I added no manure to my soil.—I am, &c.,

T. C.

NOTES.

According to "Light" Prof. Schlager, of Vienna, has been experimenting for three years on the influence of blue light in the treatment of the insane. He records a quieting and soothing influence in cases of an abnormally excitable temperament.

The number of persons killed on railways in England is proportionally twice as great as in France.

"Les Mondes" of October 6th contains an Essay on the Alimentary Prescriptions of the Mosaic Law and Modern Science which, in the main, agrees with the article on the Sanitary Legislation of the Pentateuch contained in our October number.

Dr. C. Doremus gives an analysis of the milk of the elephant, which appears to contain less water, and more fatty matter and sugar, than that of any other animal.

Dr. H. George ("Les Mondes") gives several instances of living animals which had penetrated into the human ear, and occasioned alarming symptoms.

A Life of the late Prof. de Morgan, by his widow, is about to be published by Messrs. Chapman.

One of the most curious phenomena of the age is the recrudescence of Asceticism, which seems to be forming an alliance with Spiritualism, as but too plainly manifest in the organs of the latter. Thus Dr. G. Wyld, in the "Psychological Review," recommends "occasional reasonable (*sic !*) fasts.

H. Hoffmann ("Botanische Zeitung), after experimenting for twenty-five years on the variation of plants, admits that in the course of his researches he has gradually lost the idea of species, for which he can find no characteristics. He inclines to the opinion that variation takes place in definite directions, and that its cause is in a predominating degree internal.

Mr. A. Agassiz well remarks that "the pupil studies Nature in the school-room, and when he goes out of doors he cannot find her."

A series of circumpolar stations for simultaneous magnetic and meteorological studies is about to be established by a number of States. Britain takes no part in the matter.

According to the experiments of Prof. Forbes and Dr. Young the speed of the blue ray of light exceeds that of the red by about 1 per cent.

M. l'Abbé Moigno writes ("Les Mondes," Oct. 6th), "Le jeune animal sauve sa vie, l'enfant au berceau meurt sans sa mère." He forgets that the young of the higher apes are as helpless as human children.

The value of potassium permanganate as a remedy for snake-bites is ably discussed in the "Medical Press and Circular," and pronounced not proven.

On October 26th we had the pleasure of visiting the Aylesbury Sewage Works, where the process of the Native Guano is being carried on with striking success. The exhibition of agricultural and horticultural produce grown with the sewage manure was pronounced by competent authorities most satisfactory.

At the November meeting of the Entomological Society were exhibited certain tubes constructed of weathered dogs' dung by a Lepidopterous larva, of a species as yet not determined. This is the first decided instance of coprophagous habits in the entire order.

According to M. A. Laveran ("Comptes Rendus") marsh-fevers are occasioned by the introduction into the blood of parasites, which the author describes at length. The curative action of quinine is due to its being a poison to these intruders.

Sir Wyville Thompson will shortly vacate the chair of Natural History at the University of Edinburgh. It is hoped that Dr. Alleyne Nicholson will be appointed as his successor.

Dr. J. Burdon-Sanderson pronounces the "final cause of an animal, whether human or other," to be muscular action.

Profs. Rutherford and Greenfield, in opening their classes at the University of Edinburgh, referred to the value of vivisection, and exposed the folly of the present sentimental agitation for its suppression.

MM. Arloing, Cornevin, and Thomas have investigated the well-known immunity of adult cattle from bacterian anthrax in the infected districts. They ascribe this immunity to a gradual and infinitesimal vaccination which they have undergone, since aged cows and oxen, from districts where anthrax is not common, if brought into an infected part of the country succumb as readily as calves.

This summer some common hive-bees built a comb against the flat wall of a house in Dorsetshire. Some pieces exhibited at the November meeting of the Entomological Society had evidently contained bee-grubs. This is an unexampled departure from the habits of the species.

Prof. Helmholtz makes the following significant remark:—"Our generation has suffered under the influence of spiritualistic

metaphysics: the coming one will have to be on its guard against materialistic philosophy."

"Les Mondes" notices an interesting case of melanhæmia. A French soldier who formed part of the army of occupation of Rome, and was stationed for some years in the Pontine Marshes, has become entirely of a deep brown colour, totally distinct from the shade produced in natives of Northern Europe by exposure to the sun in lower latitudes.

"Light," referring to the case of Mrs. Croad mentioned in our September issue, states that a Miss Fancher, of New York, though blind, could "read a book by running her fingers over the pages, and do the most elaborate fancy wool-work, involving the nicest discrimination of shades of colour, in pitch darkness."

According to MM. Dufour and Forel ("Soc. Vandoise des Sciences Naturelles") the glaciers of the Alps, Pyrenees, the Norwegian mountains and the Caucasus, as well as those of Greenland and Spitzbergen, have been receding. The study of this phenomenon may probably throw light upon the causes of the Glacial epoch.

We consider it our duty to reproduce the following notice from the "Journal of the Society of Arts":—"It having come to the knowledge of the Secretary that circulars, purporting to be issued by 'The Society of Science, Letters, and Art, of London,' or some similar title, and dated from Finsbury Park or Upper Tollington Park, have been sent to certain Members of the Society of Arts, inviting them to subscribe to the 'Society of Science, Letters, and Art," and that several subscriptions have been paid to the Secretary of the above Institution under the impression that it was connected with the Society of Arts, he is desired to give notice that nothing whatever is known of such a Society at this Office, and that it is not associated in any way with the Society of Arts."

M. Fredericq ("Bulletin Belg. Acad.") has examined the blood of the larva of *Oryctes nasicornis*. It is colourless, but gradually turns brown and coagulates on exposure to the air. It does not appear to contain any body like hæmoglobine or hæmocyanine which serves as an intermediary between the atmospheric oxygen and the tissues.

Mr. W. C. Holbrook, in a paper read before the American Association for the Advancement of Science, describes the skeletons of the "mound-builders" found in Rock River Valley. The cranium is small, low, and broad; traces of a frontal suture are found even in the skulls of adults. In about 50 per cent of the humin there is found a well-developed foramen, larger and triangular in the older bones, but in the more modern small, circular, and less frequent.

The following extract from microscopical observations made by Stephen Gray in 1696, and quoted by Mr. W. S. Kent in his "Manual of the Infusoria" now in progress, would seem to foreshadow the important modern discoveries of homogeneous immersion and immersion illumination :—"Having by me a small bottle of water, which I knew to have in it some of those minute insects which the deservedly famous observator Mr. Leeuwenhoek discovered by the help of excellent microscopes; having seen them with the common glass microscopes, and with the first aqueous* as above mentioned, I poured a few drops of this water on the table, and taking a small portion thereof on a pin I laid it on the end of a small piece of brass wire, of about one-tenth of an inch diameter. I continued to lay on two or three portions of water, till there was formed somewhat more than an hemisphere of water; then keeping the wire erect I applied it to my eye, and standing at a proper distance from the light I saw them and some other irregular particles, as I had predicted, but most enormously magnified; for whereas they are scarce discernible by the glass microscopes, or the first aqueous ones, within the globule they appeared not much different both in their form, nor less in magnitude than ordinary peas. They cannot well be seen by daylight, except the room be darkened, after the manner of the famous dioptric experiment, but most distinctly by candle-light: they may be very well seen by the full moon-light, and the pin sometimes takes up the water round enough to show its objects distinct." Here the side of the spherule of water next the eye acts as a plano-convex lens, magnifying the animalcule in the centre of the sphere, the opposite half doing duty as an immersion condenser, and here the matter rested and was forgotten for one hundred and eighty years.

The following rough and ready method of cleaning diatoms is given in the "American Journal of Microscopy" (ii., 1881, p. 93) :—"A few crystals of bisulphate of potass are crushed, and a sufficient portion added to the material to be cleaned. The mixture is placed in a hollow scooped in a sound piece of charcoal, and heated before the blowpipe until it ceases to fuse readily: when the substance appears to be opaque, and of a whitish colour, it is to be removed, dropped into a small quantity of water, and boiled for a few seconds. The diatoms and sand are now liberated, and can be washed and separated by any of the usual methods." It is claimed for the process that it saves the troublesome boiling in acid, and that the apparatus and materials are easily procurable.

* A spherule of water held in a loop of wire, or a hole in a metal plate.

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